THE

ELECTRICAL REVIEW.

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SUBMARINE CABLE BREAKS AND REPAIRS.

IN previous issues we have reproduced at length the paper read by Mr. Benest on the evening of March 11th at the Institution of Electrical Engineers, the subject being the history of two breaks, and of their repairs, in the South American Company's cable off the Senegal coast in the neighbourhood of Cape Verd.

We are glad to welcome a paper on submarine cable work; we have had far too few of them, and we cannot sympathise with a contemporary who would seem to consider that the subject had of late received undue attention.

It must result to the advantage of submarine telegraphy that a faithful record of the operations involved in cable laying, and more especially in cable repairing, should from time to time emanate from an authoritative source, and that free scope should be given to the discussion of the circumstances attending the repairs and to the criticism of the methods prosecuted. We are not sanguine that many striking novelties or that some new or remarkable departure will, in every case, result from the ventilation of a subject whose details are only too frequently treated with reticence, but we do believe that our knowledge will be increased and our experience be enlarged by an unreserved publication of chronicles such as the one under notice; it is a matter for congratulation that among cable companies there is one, at all events, which permits its employés to place before us a narrative of their operations, and to frankly recount the history of their failures and successes.

The merely narrative portion of the paper has, for the general reader, an interest of its own since it contains descriptions of climate, weather, locality and incident, and recounts the day to day vicissitudes undergone during the prosecution of the work. If any adverse criticism could be made of a story so complete, so redundant in fact of detail, we might observe that certain incidents are pourtrayed in a style more suited to the pages of a popular magazine than to the purposes of a technical dissertation.

The more abstruse questions dealt with in the paper, and connected with the physical conditions of the sea bottom, would, at first sight, appear to come within the spheres of the geologist and physiographist, while the classification of the bottom specimens would seem to exclusively belong to the domains of the naturalist and the chemist, rather than pertain to the work of a submarine cable engineer. But it cannot for a moment be denied that the sciences of geology and physiography can lend valuable assistance towards solving many of the problems related to the changes taking place in the ocean bed, and it is also evident that the labours of an analyst in comparing the characteristics of the bottom deposit between one locality and another, may be of the greatest service in determining many questions otherwise difficult of solution. These possibilities amply justify, in our opinion, the extension given to the paper in detailing

the work of the analyst, and in liberally quoting scientific and expert testimony.

Our argument points to a wide field being offered, in cable repairs, for general investigation and research, and we quote certain facts adduced by the author which point to the absolute necessity of inquiries such as those alluded to. We are told that in both the 1893 and the 1895 repairs the cable was found to be buried for a considerable distance on each side of the break; that the mud along that portion of the cable so buried was soft and almost fluid, and of a different character to that outside the immediate sphere of operations, being of a stiff consistency; that in the neighbourhood of the 1893 break the bottom mud contained an abundance of mineral deposit, while in the case of the 1895 break there was a scarcity of such matter; and that at the locality of the last break a greater depth by 200 fathoms was met with than previous soundings would have led one to expect. To the debatable question as to the cause of the break, additional interest is lent by other physical conditions mentioned by the author, such as the proximity of the Senegal River; the configuration of the land which tends to the formation of eddy currents; and the existence of a gully close to the scene of operations, whose axis if prolonged would cross the line of cable at right angles.

We believe that we have correctly rendered the more prominent features connected with the situation, but a question occurs to us which does not appear to have been touched upon either in the paper or in the subsequent discussion; this question is as to the position of the broken ends when picked up as compared with the position of the cable when laid. We noticed on one of the charts that at the locality of the break, the line indicating the cable as recovered appeared to be some distance to the westward of the line of cable as originally laid. This is of interest, as the positions, if to be relied upon, would indicate that the cable had shifted downwards along the continental slope, a direction, it is to be noted, which would be taken by a moving mass of bottom mud.

Although Mr. Benest appeared to favour the idea that the break was to be attributed to a submarine landslip, a theory in which the majority of those who took part in the discussion seemed to coincide, the author would not commit himself to any decided opinion as to the causes which set the bottom mud in motion. That the break was due to a movement of the bottom mud is strongly countenanced by the conditions and circumstances present, and the fact that the gradients appear to be so very insignificant would not weaken this view, as mud of the thin consistency described might be easily set in motion on a comparatively gentle slope.

Various causes which could have led to a submarine landslip were suggested in the discussion which followed the reading of the paper. The vibratory action of storm waves; an unusually heavy underflow following the piling up of the surface water on the coast through a prevalence of westerly winds; our old friends submarine earthquakes and volcanic disturbances; and the outbreak of a submarine river either in the form of filtration or in a current flow, were in turn called into requisition. Some extraordinary facts were brought to light in connection with lacustrine systems both superficial and subterranean, and their relationship to distant outflows, and of equal interest was the evidence adduced with regard to subterranean rivers possessing submarine outlets. The arguments in favour of some such phenomena as the last mentioned being responsible for the shifting of the bottom mud certainly carried with them considerable weight.

So far as we can gather from a careful perusal of the paper, no bottom or serial densities appear to have been taken. This omission of an investigation which would seem to offer direct proof as to the presence of a submarine outflow of fresh water is to be regretted in view of the doubts existing as to the causes of the break.

We were disappointed at the absence of many practical and scientific men, such as geologists and naturalists, whose presence and whose opinions would have lent additional interest to the discussion. The time of the meeting might then have been occupied in debating questions pertinent to the point at issue, and we should have been spared a good deal of inconsequent and frivolous chatter.

To show that this criticism is not too severe, we will quote a few examples from the discussion.

The contribution of a certain gentleman towards a solution of the problem connected with the cause of the break was scarcely happy. He must have been dreaming; indeed, his attitude lent force to this supposition, when he suggested that the break took place during the repairs, when as a matter of fact the break occurred nearly two months prior to the repairing operations.

One expert who, although provided with a brief of formidable dimensions had evidently neglected to study it, derided the notion that the vibratory action of storm waves could be felt beyond a depth of 20 fathoms; not satisfied with this unfortunate preamble, he immediately gave an instance, within his own experience, of the results of such action being distinctly noticed at a depth of several hundred fathoms. He further elaborated a scheme of pinnacles and chasms, over or across which he declared the cable must have been suspended. We at once referred to the chart containing the drawings illustrative of the bottom profiles at and about the break, and these showed what we should consider to be a fairly level and regular bed. Another gentleman whose contribution to the debate, while showing a poetic fancy which did credit to his imagination, did not impress us very favourably as to his knowledge of submarine cable work, drew a vivid picture of the dangers lying in wait for a yet embryonic cable through some maleficent volcanic agency. We would endeavour to allay the fears of this pessimist by reminding him that certain Mediterranean cables are laid in the vicinity of Stromboli, Etna, and other centres of disturbance, and that the submarine telegraphic connection with Australasia is maintained through regions notably subject to frequent volcanic eruptions. It surely is not pretended that these cables ought never to have been laid.

Again, we were asked to listen to a rambling dissertation on the comparative merits of India-rubber and gutta-percha as insulators for submarine cables, and the same authority who lent this variety to the general performance considered the occasion a fitting one for advertising a patent tank or sink to be constructed in cable huts at shore end landing places.

We were also interested to learn from another scientist that the chemical action of thermal springs might account for the rupture of a cable by torsion or tension. We are aware that some mineral waters are gifted with twisting or

contorting properties, and that even iron wires sometimes suffer from certain chemical actions, but these instances are not to the point.

Surely it was within the powers of the worthy President to have confined the debate to the subject actually in question, and while admiring his patience and good nature, we think he might have prevented the waste of time consequent on the ventilation of so much irrelevant matter.

The paper was profusely illustrated by lantern slides, among which, perhaps the most interesting, were excellent pictures of various specimens of oceanic deposit.

In conclusion, we can confidently recommend the perusal of Mr. Benest's paper and of portions of the discussion to all interested in submarine telegraphy, and more particularly the parts which deal with the probable or possible causes of the break, since the solution of a similar problem may at any moment devolve upon the cable engineer.

Electrical Power from Nile Cataracts.

It is reported from Egypt that Professor George Forbes has been examining the Nile Cataracts, with the idea that the power, which undoubtedly exists in the falls, can be profitably utilised. The questions are, whether the necessary works would not absorb a capital expenditure per horse power delivered far in excess of that required in establishing power stations, worked by other means; and whether industries for the use of power are ever likely to spring into existence at or near the cataracts, or even within 50 miles of them? For instance, the second cataract has a fall between Shelal and Wady Halfa of about five metres in a distance of about seven miles. The bed of the river follows a section which shows a series of short inclines of about 1 in 40, here and there a little steeper. To use a portion of the mass of water that passes down this section of the river—the width being about half a mile—without the construction of a weir, would mean a diversion at a point above Shelal with the lowest end of the tail race close to Halfa, a suitable intermediate point, so as to save excavation, being selected for the turbine station. During low Nile, *i.e.*, during nine months of the year, such a canal and cutting to give two or three thousand horse-power at the power-house, is feasible, and, with the cheap labour obtainable in Egypt, such a work might be carried out and installed for £50 per E.H.P. But, at present, with the exception of the railways, namely, one to Abu Fatmeh, 203 miles, and the other to Abu Hamed (in course of construction) 239 miles, there are no industries requiring power within 200 miles of Wady Halfa. But even if industries existed, the abnormal conditions during the three months of what is known as "high Nile," when the whole surface of the river both above and below the cataract, or rapids, rises from six to ten metres, upsets all the calculations for and conditions of any works designed for using the power during the rest of the year. At such a time, the suggested canal, turbines, and tail race, would be perfectly useless. A weir, with sluices to regulate the effects of the flood waters, can of course be imagined; but the scale and dimensions when dealing with the enormous mass of water at the time of high Nile, puts it out of the range of practical commercial engineering. The floating turbines, suggested years ago by Mr. Liardet, and others, have only to be examined into by practical men, to show that their application on the rapids of a great river like the Nile, on a practical scale, is the dream of a visionary. The question is, whether any scheme for the utilisation of the power of a river which is subject to an annual alteration of levels, as is the case with the Nile, has ever even reached the stage of practical design. We shall be glad if Professor Forbes on his return can even indicate in what direction his investigations enable him to point, as a solution of the question. Easier problems of the same character are met with elsewhere, for instance, on the Rhine above Basle, where the country is covered with industries ready to buy electrical energy if it could be supplied. When these have been tackled and made to pay, it may be time enough for the Nile problem to be faced. In the meantime we wait an announcement of the Professor's views.

Technical Education.

We have ever ranked ourselves amongst those who have clamoured for more facilities for obtaining good technical education. We have always considered that the matter has been one not only of individual interest, but also of national concern. We believe that in the immediate future, that nation will succeed in winning its way to the front, which provides the greatest facilities to its citizens for making themselves *faciles princepes* in the arts and sciences. It is wonderful to think that England should have persistently neglected this branch of national development. Whilst England has been resting upon her record, Germany and France have been going ahead. State supported schools have been growing up, and everywhere facilities have been arranged for, by means of which it is possible for earnest workers to obtain that knowledge which will best fit them for competition amongst the nations. In England, as we have said, we have been content to rest upon our oars; and what has been the result? Already within the last few years we have found ourselves behind the times. Germany and France, and even less important countries have been pushing us apace, and why? Simply because in these countries facilities are offered by the Government, which enable those who wish to get on, to succeed. We have in this country no State supported laboratories, no encouragement is given to those who wish to succeed or who are desirous to contribute to the sum total of scientific knowledge which is possessed by the people at large. The effect of this has made itself felt in some matters of trade. To-day we stand at a far greater disadvantage than we did 10 years ago; other countries are trespassing upon our preserves; we cannot command the markets as we used to do, and all because we, as a nation, do not recognise the importance of providing facilities for training the integral parts of the nation. We were thankful to note that at the recent meeting of the British Association, a resolution was arrived at praying the Government of this country to establish laboratories for research. For a long time there had existed in Germany and other continental countries such laboratories, State supported, and provided with means by which it has been possible for knowledge to be won, and when once knowledge has been thus won, the natural result will follow, and the well-being of the country will be assured. The thanks of the nation are due to the thousand or two of individuals who compose the British Association for the Advancement of Science, in as much as they have made a strong representation to the powers that be to State-support laboratories for research. Until we recognise that the well-being of the country depends upon the proper recognition of this fact, we shall only succeed in dropping behind other countries. We trust that these powers that be will realise the importance of the issues which are within their hands, and that the establishment of laboratories for pure research will be recognised as part of a national policy. Were this to be the issue, we are certain that the industries we represent would benefit, and that the competition from which we suffer from abroad would take its proper place.

D

THE INSTITUTION OF CIVIL ENGINEERS.

It is not a little curious to see how the various Institutions are falling into the hands of the scholastic element. The professors of this country possess in a large measure the gift of self-advertisement. They have huge facilities for this sort of thing. At the expense of the public they are provided with every manner of scientific implement for purposes of experimental testing, and with a large staff of salaried assistants, and others in the shape of students, and the results of tests and experiments thus cheaply carried out are published as papers before the learned Societies. Long drifting in the general stream towards the same condition, the Institution of Civil Engineers has taken a step of a distinctly unpractical kind. Henceforth, fitness for membership is dependent in a sense upon the passing of "such examination or examinations as are appointed or recognised by the Council," or upon the writing "of a paper on a professional subject." Obviously such a course is laid especially for the benefit of students and professors. The engineer in long practice would often fail at an examination such as would sooner or later come to be set, for whatever merits the earlier examinations may possess, it cannot for a moment be doubted that they would soon come to mean very little else than a mere class-room paper and practical knowledge would be relegated to a back seat.

As a contemporary justly puts it: "The real objection to examinations is that they encourage cram, and cram is the worst brain-destroying poison yet discovered and the most fatal to any original thought." The value of exams., to our way of thinking, is mainly as a means of *preparing* for the work of life, because they help to concentrate the little knowledge one may possess; to collect it from the odd corners of one's brain and bring it down, as it were, to one's finger-tips. That is all! Experience has taught that there is often more luck than merit in the passing of exams.

There is a third alternative dispensing with the paper or the examination, which simply means that a candidate must be approved by the Council. It may be argued that the examination test is simply an adjunct to the other qualities of fitness, and, could this be assured, perhaps no great harm would result, but such cannot, we fear, be assured. Certain it is, however, that for some years past admission to the Institution has been such as to very greatly discontent large numbers of its members who have long felt that hard practical experience and sound knowledge to boot, have played second fiddle to the professorial element. The latest move has not tended to reassure these members. A contemporary deplores the bearing of the new rules upon men who are not engineers, but rather organisers. We really cannot see, however, that this can be held to be a hardship. Another, the *Engineer*, approves of the recent step as likely to raise the status of engineers. In the opinion of our contemporary a good deal of the poor opinion of the public as regards engineers arises from the lax and general use of the term. Everyone is an engineer who cares to assume the title, from the plumber, the hot water man, or the gentleman who attends to the details of sanitary appliances, to the expert who, in the witness box, swears to anything or everything according to guineas. Not, however, the man on the locomotive, as the *Engineer* would have it, we term him correctly the engine driver because he succeeded to the coach driver. In America they call him the engineer because he drives an engine made by correctly termed machinists and designed by engineers. One might as well call a gardener a smith because he drives a spade as call an engine driver as the Americans do. The last move of the Institution of Civil Engineers is called a step in the right direction because it will lead in time to the placing of the profession on a par with that of the law or medicine. This is all very well in a sense, but we are a little doubtful about the matter. The examinations for both law and medicine are such that a very large number of mediocre men get through, and everyone has had some experience of the ignorance displayed by some medical men, who cannot be successfully prosecuted even when they have made grave errors of which an ignorant layman could scarcely have been guilty. Similarly, in law, the public has to pay for an enormous mass of unsound advice from full fledged solicitors who have passed through the sieve of the examinations, which should shut out the incompetent. We should, ourselves, like to see the engineering profession take a high standing, but it will never do this purely on an examination basis. Examination is almost bound to drift into the direction of "intellectual mathematical gymnastics," and necessary as this may be to a limited extent, it is a fact that engineering is not, nor can it ever be, a purely mathematical science. Many of the very best engineers have been mere children in their knowledge even of quite elementary mathematics. The mathematical engineer is almost certain to take up with teaching, and the practical engineering of a teacher is often sadly deficient in economy. Can we hope that the side doors will be of much avail to admit those who are sieved out by the fine sieve of examination. What of the ability to write a paper—call it a thesis if you will. To many men the writing of a paper is mere child's play, and a man who has a facile pen will often skim a subject and write a fair paper where the man who knows will flounder in a mass of unintelligible rubbish. We would not carp too much at an honest attempt to mend existing matters. At present the fact of pupilage to a well known man will admit to studentship and progress follows. Yet how many students are there whose whole pupilage is a mere idle sham?

In favour of some change, there is the fact that any wealthy manufacturer of iron goods stands a better chance of admission than his own poor draughtsman. Yet one man has simply the gift of money making, the other is probably a genuine engineer, versed in physics, in chemistry, and in mechanics, yet he never gets beyond the reproachful title of "my draughtsman," for it is a fact that the position of draughtsman carries with it little beyond the above title. The trading engineer who simply manufactures to sell, uses the man of brains to do all his designing, and indicates him by the possessive pronoun as a chattel. Doubtless there are many poor draughtsmen who are burning for the test by examination, and when they have got their C.E., they will half starve to pay for it, while, perhaps, the possession of a large works will let in their possessor by the side door that is always open to the wealthy. The subject is a difficult one, however looked at, but the Institution of Civil Engineers is supposed to be an institute of engineers, not of financiers, company promoters, or millionaires, and if the new rules bar the entrance of such men, there may be some good in them after all, but we fear they will always get in, no matter what the rules, and that too many sound practical engineers will be excluded. Doubtless whatever rules were made and rigidly adhered to would let in much bad and shut out much good material, but the recent grumblings have been directed more against the manner in which rules have been relaxed or hardened by the Council. There seems to be a feeling that the members should have more voice than is now allowed them in the choice of new members, and that less should be left to the Council whose recommendation of a member or their adverse decision should follow rather than precede the opportunity afforded for the general judgment of the members as a body.

THE GAS ENGINE INDUSTRY IN AMERICA.

Our New York contemporary *Electricity*, which professes to be favourable to the gas engine, has a very strong leader condemning the methods of the gas engine manufacturers. It is stated that while in Europe the gas engine has been used for electrical work and other industries and has made great strides, yet in America progress has been slow, and is described by our contemporary as retrograde. This is held to be due to the want of a proper appreciation of business necessities by the makers of gas engines. Intelligent information is not to be obtained of the kind that is furnished by every reputable maker of steam engines. Data as to performance are unobtainable or nearly so, and such as have been published contain figures which, if the gas engine makers are satisfied with them, are themselves a sufficient condemnation of those makers and suggest a doubt of their fitness for the business. It would appear, indeed, from what our contemporary writes that the industry is in a poor way in America, but to our mind it is in a poor way simply by reason of the same causes as have lead up to the success of electric lighting in

that country. These reasons are easy to understand when we consider the relation of two factors here and in America.

The first of these factors is the price of coal. We believe that speaking generally coal as steam fuel is fully as cheap in America as it is here. Relatively to wages and many other items coal is cheaper in America than it is here. On the other hand, illuminating gas is very much more expensive in America than it is in England. Probably it is fully double the price. As a result there is far less inducement to use gas engines in preference to steam engines for the generation of electricity. There is, on the other hand, less inducement to use electricity in England in place of gas as an illuminant. In America electricity need not cost more to manufacture than it does here; but the cost of gas being double, gives to electricity a special advantage, and the same expensive gas precludes the use of gas engines. Where there is not much call for gas power, it is pretty certain that its supply will be but poor. The very paucity of the supply chokes off such demand as there may be. It seems clear to us that the very extravagant price of gas in America is at once responsible both for the magnificent success of the American electrical industry and the poverty of the gas engine industry.

Whether this be sufficient to account altogether for the apathy displayed by American engine makers is perhaps open to doubt. Certain it is that the exhibit of engines at the recent Gas Industries Exhibition was so small as to be ridiculous, and all the best known makers were absent; from which our contemporary infers they were afraid to subject their wares to criticism and inspection. Yet the two makers who did exhibit reaped a rich reward. It would almost seem that despite the heavy tariff, there should be an opening in America for some of our own high-class gas engines.

BONDING RAILS WITHOUT DISTURBING THE PAVEMENT.

The recently discovered elastic copper is used by Thomas A. Edison and Harold P. Brown in a new form of rail bond called the E C A (elastic copper amalgam). The form shown in the accompanying cuts, which are reproduced from the *Street Railway Journal*, is especially designed for rebonding girder rails without disturbing the pavement. A large electro-magnet whose pole-pieces fit the head of the rail, is used to hold the drill to its work and to support a hardened steel template with a pair of intersecting holes. These holes are bored in the tram at the end of each rail so that one is

Fig. 1.—Section of Rail showing Bond.

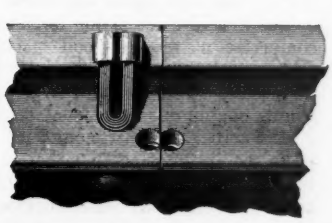


Fig. 2.—Bond ready for Insulation.

in each, and so that they enter $\frac{3}{16}$-inch into the upper edge of the angle plate, as shown in fig. 1. The terminals are made of the Edison elastic copper, welded to flexible copper conducting strips which are bent into shape of a U. These terminals are cylinders with one side flattened. Their surfaces are covered with the Edison flexible solder, which serves to make a perfect electrical contact and prevent rusting.

After the holes in the rails are amalgamated, the U-shaped portion of the bond is passed through the slot connecting the holes, and the terminals driven home, their flattened sides coming together with $\frac{1}{32}$-inch compression. This establishes two paths for the current, one through the U, which is heavy enough for the maximum current, and the other directly across the terminals. The elasticity of the copper maintains the latter contact even when the rails have slackened apart $\frac{1}{32}$-inch. The terminals are driven below the surface of the tram and the steel is burred over to retain them in place.

The wear of waggon wheels, of course, tends to increase the bur and keep the terminals down. The edge of the angle plate also shares in carrying the current. Fig. 2 shows the bond ready for service, and fig. 3 is a section of rail and angle plate showing position of bond. Tests of a number of different rail bonds were made in February by a Franklin Institute Committee, and the C E A bond was found to carry 1,500 amperes with but ·018 volts loss, the temperature of the bond being practically the same as the rail. The rails were then slackened $\frac{1}{32}$-inch without increasing the drop,

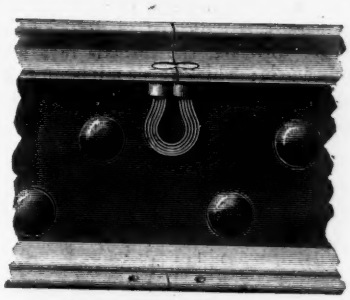


Fig. 3.—Bond in Position.

proving the elasticity of the copper. The angle plates were then entirely removed, the rails separated $\frac{1}{2}$-inch, and the same current passed through the U. The drop was still less than one-half that of the best of the ordinary copper bonds, and its temperature below 110°, while the copper bonds of same section varied from 200 to 496° with same current. It is stated that a considerable part of the new work in New York City will be done with E C A bonds.

Many roads with an old stock of copper bonds on hand are following the suggestion of G. W. Knox, of the Chicago City Railroad, and applying Edison amalgamation and flexible solder to the bond terminals, thus cutting the resistance down to one-third, and preventing corrosion.

ROENTGEN RAY BURNS.

By ELIHU THOMSON.

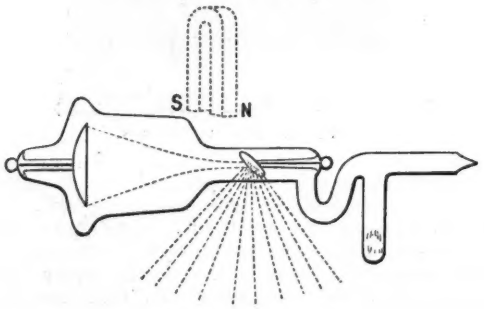
The cause of the injury to the skin which follows an exposure to a source of Roentgen rays is still a subject for discussion. It is known that a comparatively short exposure at sufficiently small distances from the source will produce the effect. It has been claimed by some that Roentgen rays do not produce the mischief, but that the effect is essentially electrostatic. Others have expressed the opinion that ozone and other substances present in the neighbourhood of the excited tube are the real causes of the injury.

It has seemed desirable to set at rest, by experiment, these doubtful theories. The very peculiar nature of the injury itself, its course of development, the accidental circumstances under which it has occurred, have all tendod to negative any theory except that which regards rays from the tube as the true cause. These rays might be either Roentgen rays, or rays so closely analogous as to be with difficulty distinguished therefrom.

The first effect after exposure is a slight reddening of the skin which is made more easily discernible by a little friction over the spot affected. This lasts two, three, or more days, and tends to fade. In the writer's experience, at the end of a week there has been an almost complete absence of any noticeable effect on the skin. On the ninth day, however, the affected part was found to redden, and this increased for a few days until blistering and sloughing took place with slow and tedious healing. These effects were noted in the case of the exposure of the little finger of the left hand, and are at present in progress upon a portion of the third finger of the same hand, in consequence of an exposure for only 12 minutes to the rays from a special tube. This tube was made for the purpose of

obtaining strong effects by lessening the working distance from the bombarded spot on the platinum, which is the source of the rays.

The figure shows the general form of the tube. It is narrowed around the platinum anode and the glass is also made thin around the same. It is thus possible to get the finger, the fluorescent screen, or the photographic film, very close to the bombarded spot on the platinum anode. The distance need be not over one-half an inch as a minimum. By the use of a magnet the spot on the platinum could be shifted so as to be very close to the glass and upon the edge of the platinum sheet. The intensity of the radiation per unit of surface was increased, thereby, according to the law of inverse squares, which seems to hold in this case. This use of the magnet is indicated in dotted lines and is very convenient for directing the cathode rays upon any part of the platinum anode; which anode might in fact be faced with a variety of different substances, or have its surface differently formed, or curved at places while the cathode beam



could be directed first to one part and then to another and the effects noted. If a platinum anode has been perforated by the beam at one point the tube is still useful, for a slight effect of the magnet puts the beam upon a new surface. Many a good tube may thus be made to do service even after several holes have been melted through the platinum sheet.

With such a source of rays as the tube illustrated, it was easy to try an experiment, the result of which seems to the writer to leave no doubt of the fact that Roentgen rays, or rays of the same general characteristics, do actually cause the burns and injury which may follow prolonged exposures to the Roentgen radiation. The left hand was covered with a lead sheet of over $\frac{1}{16}$th inch in thickness, and an oblong hole of about three-fourths of an inch long and about $\frac{5}{16}$th inch wide cut through it at the part just over the third finger between the first and second joint. This limited the passage of rays to the part of the finger under the opening. But around the finger and under the middle of the opening was placed a strip of heavy tinfoil about $\frac{3}{16}$th inch wide. This divided the exposed area into two parts. One of these parts in turn was covered with two layers of thin aluminum leaf gummed to the finger. Thus there were, in fact, three spots on the finger within the opening, one covered with aluminum foil or leaf, another with heavy tinfoil, and the third left entirely bare. The opening in the lead sheet was brought close to the platinum anode, see figure, so that the finger was about $\frac{3}{8}$th inch distant from the bombarded spot.

The exposure was for a period of twelve minutes, which it was thought would be sufficient. The result at first was two faintly reddened spots, one having the outline of the part under the opening in the lead shield covered by the aluminum foil, and corresponding thereto, and the other corresponding to the bare spot. Under the tin-foil strip there was no action. These reddened spots though scarcely visible, could be developed by slight friction, but gradually faded until, at the end of a week, from the time of exposure, they were with great difficulty distinguishable from the rest of the skin, even after the spot was rubbed. On the ninth day, however, they returned and the spots became painful and a little swollen. This has continued to increase and will probably end in blistering, sloughing and final healing. The part covered by the tin-foil is sharply marked from the others in being entirely unaffected. The effect produced through the aluminum leaf is about the same as on the bare spot, showing that thin aluminum does not stop the rays which produce harm.

It is needless to say that the effect is proven by ths experiment to be neither *electrostatic*, nor *ozonic*, but merely a result of certain rays reaching the skin surface, and such rays are probably those of the Roentgen rays not readily absorbed. According to the law of inverse squares an exposure of 12 minutes at 5—8 inches distance would require, at 10 inches distance, for equal effects, about 50 hours, or over two days. There is, then, no occasion for any alarm at the effects of Roentgen rays, as exposures of sufficient duration to produce harm are rarely if ever necessary. In regard to the claim which has been made that injury only follows exposures made by induction coils, while static machines do not produce the effect, it may be said that in the writer's former experiment, of which the little finger was made the subject, a large capacity static machine was used, and the result was severe enough. The present experiment was made with an induction coil as the source of electric discharges, and as yet there is no difference in the results. The effect is now, of course, limited to two small spots a little distance apart.

PORTABLE TESTING SETS.

A Method of Steadying Galvanometer Defections.

It has often been remarked that in America the design of physical, and in particular of electrical, apparatus follows the lead of English patterns, thus affording a very marked contrast with electrical engineering apparatus, specimens of which are to be found all over this country in connection with electric lighting and traction work. The Elihu Thomson meter is a good example of the latter class, but even this we have been assured by one who professes to know was in reality first designed by Hümmel, a well known German engineer and inventor, who has, by-the-bye, just completed a pattern of meter, about which we shall have something to say very shortly.

Messrs. Queen & Co., of Chestnut Street, Philadelphia, have, as instrument makers, ceased to hold their old position, but a few years ago when in their prime, this firm repeatedly brought out apparatus which bore a remarkable resemblance to patterns arranged by some of our leading English firms a month or so before the appearance of the American "designs." This matter has at various times been touched upon in our columns, and we have now to describe two forms of testing sets which bear a resemblance to one another in more than one particular; a coincidence, perhaps, but not less striking all the same.

The first of these is due to Messrs. Nalder Bros. & Co. It comprises a moving coil galvanometer of the Deprez D'Arsonval type, the deflections being read by a telescope and scale. The instrument is provided with a set of four shunts having one additional contact connected as a short-circuit across the galvanometer. A three-point switch connects the instrument to either a coil of 100,000 ohms for taking the "constant" or to the cable or "x," the third position being "off" and breaking the circuit. The changes in connection are effected by small lever switches, so that there are no plugs to be mislaid or kept in order.

The set is intended for insulation testing by the direct deflection method, and for this purpose the galvanometer, shunts, and switches are mounted in a box supported, when in use, on a tripod. To reduce the dimensions as much as possible, the mirror is concave and of short focus, and the scale is consequently much smaller than that which would otherwise be necessary, although the combination gives about the same result as with the ordinary metre beam of light in a reflected ray instrument. When the testing battery gives 100 volts, resistances up to about 50,000 megohms can be measured.

The second arrangement to which we have referred has been brought out by Messrs. E. G. Willyoung & Co., of Philadelphia. Mr. Elmer G. Willyoung was, we believe, one of the principal men on the staff of Messrs. Queen & Co. in years gone by. This set is made up of a moving coil galvanometer swung on gimbals, and adjustable about two axes

passing through its centre, the one perpendicular to its plane, the other lying in its plane; brass milled head screws being used to give adjustment in each direction. Deflections are read by a telescope and scale which are attached to the extremity of an arm pivoted on an axis lying in the plane of the galvanometer and passing through the centre of the mirror. This arm lies flat in the bottom of the containing case when not in use, the scale being removed and placed in clips provided for it. When in use the arm is raised and scale fixed in position, the arm making an angle with the horizontal of from 30° to 40°, and the mirror being adjusted to suit this. The box in which the apparatus is secured can be placed on the ground or a suitable support, and the galvanometer levelled by the gimbals when all is ready for testing, no tripod being required.

The shunts provided are four in number, $\frac{1}{1}$th, $\frac{1}{10}$th, $\frac{1}{100}$th, $\frac{1}{1000}$th and $\frac{1}{10000}$th (whereas in the Nalder set they are $\frac{1}{1}$th, $\frac{1}{10}$th, $\frac{1}{100}$th and $\frac{1}{1000}$th). A couple of keys, plug switch, and resistance of 100,000 ohms complete the accessories. This set also measures up to 50,000 megohms with 100 volts testing pressure.

One interesting detail is worth attention, as lead sheathed and armoured cables are now in general use and electric traction is spreading. Such cables are often difficult to test owing to stray return currents making their way along the uninsulated sheathing, and as they vary in magnitude or direction, induced E.M.Fs. are set up in the conductor of the cable under test rendering the insulation deflections unsteady and erratic. To overcome this difficulty there is placed in series with the galvanometer a resistance of 100,000 ohms wound inductively. The impedance of this added resistance reduces the variation that can take place in the testing current, but does not interfere with it beyond tending to reduce the sensibility of the set. The shunts are connected across the galvanometer coils, and 100,000 ohm coil (these being in series) and as the latter has a small temperature coefficient the multiplying ratio is kept constant despite any change in temperatare of the galvanometer coil or even a change of coil or suspension.

The Nalder set was got out, we understand, for the City of London Company, and the Willyoung for the Union Traction Company, of Philadelphia, U.S.A. These combinations show that the testing truck with its reflecting galvanometer and elaborate accessories has been found too clumsy and cost too much for transportation, while there has arisen a demand for something better and giving a larger range than is obtainable by a direct-reading ohmmeter or a small galvanometer with pointer, combinations which may be conveniently used in taking house wiring insulation, but are not quite good enough for testing short lengths of highly insulated cable after laying.

EQUALISING CONNECTIONS FOR COMPOUND-WOUND DYNAMOS COUPLED IN MULTIPLE.*

By E. R. KELLER.

(*Concluded from page* 541.)

If, in fig. 3, we let

a = resistance of positive lead and series field;
c = resistance of negative lead and parallel resistance of armature and shunt field;
} for the machine whose E.M.F. = E;

b = resistance of positive lead and series field;
d = resistance of negative lead and parallel resistance of armature and shunt field;
} for the machine whose E.M.F. = e;

r = resistance of external circuit;
x = resistance of equaliser circuit, and

A, C, B, D, R and X = respectively, the currents in the different branches of the circuit, we have, from Kirchoff's laws:

$$C = A + X \quad (1)$$
$$R = A + B \quad (2)$$
$$D = B - X \quad (3)$$
$$C\,c + X\,x - D\,d = E - e \quad (4)$$
$$C\,c + A\,a + R\,r = E \quad (5)$$
$$D\,d + B\,b + R\,r = e \quad (6)$$

Solving these equations for A, B and X, we obtain, by making the necessary transformations and reductions:

$$(A + X)\,c + X\,x - (B - X)\,d = E - e$$
$$(A + X)\,c + A\,a + (A + B)\,r = E$$
$$(B - X)\,d + B\,b + (A + B)\,r = e$$

$$A\,c - B\,d + X(c + d + x) = E - e$$
$$A(a + c + r) + B\,r + X\,c = E$$
$$A\,r + B(b + d + r) - X\,d = e$$

$$A(a + c + r)(c + d + x) + B\,r(c + d + x) + (E - e)\,c - A\,c^2 + B\,c\,d = E(c + d + x)$$
$$A\,r(c + d + x) + B(b + d + r)(c + d + x) - (E - e)\,d + A\,c\,d - B\,d^2 = e(c + d + x)$$

$$A[(a + c + r)(c + d + x) - c^2] + B[r(c + d + x) + c\,d] = E(d + x) + e\,c$$
$$A[r(c + d + x) + c\,d] + B[(b + d + r)(c + d + x) - a^2] = e(c + x) + E\,d$$

$$A = \frac{[(b + d + r)(c + d + x) - d^2][(d + x)E + e\,c] - [r(c + d + x) + c\,d][e(c + x) + E\,d]}{[(a + c + r)(c + d + x) - c^2][(b + d + r)(c + d + x) - d^2] - [r(c + d + x) + c\,d]^2} \quad (7)$$

$$B = \frac{[e(c + x) + E\,d][(a + c + r)(c + d + x) - c^2] - [r(c + d + x) + c\,d][E(d + x) + e\,c]}{[(a + c + r)(c + d + x) - c^2][(b + d + r)(c + d + x) - d^2] - [r(c + d + x) + c\,d]^2} \quad (8)$$

$$X = \frac{E - e - A\,c + B\,d}{c + d + x} \quad (9)$$

from which the currents in all the branches of the circuit may be calculated, if the resistances are known and the E.M.Fs. assumed.

It may be of interest to show, from an example, what is liable to occur in actual practice.

At one of the hotels in this city the electric lighting plant consists of two direct connected compound-wound multipolar generators, intended to give 400 amperes each at 115 volts. The internal resistances of the machines are as follows:—

	Armature.	Series coils.	Shunt coils.
First machine	·011	·0041	15·5
Second machine... ...	·015	·0036	11·5

The leads of the machines and the equalisers, which are arranged as in fig. 2, are all about 20 feet long (to the switchboard), and they are made of a cable of 350,000 circular mills cross-section, so that

a = ·0047 ohms,
b = ·0042 ohms,
c = ·0116 ohms,
d = ·0156 ohms,
x = ·0012 ohms,
r = ·1437 ohms (at full load).

Since the machines are direct connected, there is a possibility of a variation in speed in the two dynamos, and, furthermore, there is quite a little difference in the characteristic curves of the two machines, although the field frames and armatures were intended to be exact copies of one another. Hence, a change of load may produce a material difference in the generated E.M.Fs. Let us assume that, at full load, both machines were generating exactly 115 volts, at which voltage the current in each armature was 400 amperes, but that a change of load and speed has caused the pressure of one of the machines to fall to, say, 110 volts. If, then, we substitute the values given above for the internal resistances

* Read before the Electrical Section of the Franklin Institute, and reproduced from the *Journal*.

and for E and e, the values 115 and 110, respectively, we have from (7) and (8)

$$A = 390 \text{ amperes},$$
$$B = 374 \text{ amperes},$$

for the values of the currents in the series coils. That is, for a difference of 5 volts in the two machines, we have a difference of only 16 amperes, or about $3\frac{1}{2}$ per cent. in the series field currents.

The current in the equaliser from (9) is

$$X = 222 \text{ amperes},$$

and in the armatures from (1) and (3)

$$C = 612 \text{ amperes},$$
$$D = 152 \text{ amperes}.$$

In other words, a difference of 5 volts in the E.M.Fs. of the two machines has caused a flow of current in one armature which is over four times as great as that in the other, while the equaliser has made the currents in the series windings nearly equal, there being a difference of only $3\frac{1}{2}$ per cent.

Of course, these results are not accurate, because we have entirely neglected the resistances of the switches, fuses, and contacts in the calculation. At the same time, the results show to what extent the generators might be unbalanced under adverse conditions; and, moreover, it is evident that the equaliser may be called upon to carry currents of very considerable strength.

There are three factors which exert an unbalancing influence on a system of generators coupled in multiple:

(1) A variation of speed in one or more of the generators.

(2) A variation in the external load.

(3) A variation in the strength of the magnetising current.

The first of these, speed variation, is, perhaps, the most serious, and we cannot attach too much importance to the matter of inherent regulation of the prime movers, the belt transmission and other factors which affect the speed of the generators.

The second, variation of the external load, affects the distribution of the load the more, the greater the divergence between the characteristic curves of the machines. As already stated, the development in this respect during the past few years has been very decided, and there is, as a rule, but little trouble from this source.

The third unbalancing factor, viz., a change in the strength of the magnetising current, is of a secondary nature, and would, evidently, not exist were the speed of the prime movers and the E.M.F. of the generators absolutely self-regulating. This is not the case, however, and, consequently, any variation in the distribution of the load due to the first two causes is aggravated by the third. As already stated, it is the function of the equaliser to remedy this, and it was shown that this cannot be done absolutely except by making the resistance of the equaliser = 0.

In the arrangement of Gramme and Mordey the equaliser must always have an appreciable resistance, and consequently

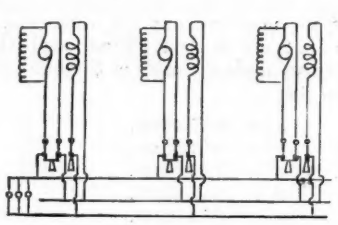


Fig. 6.

there will always be a loss of potential in it. Moreover, this loss of potential is always at the expense of the weaker machines.

I desire, in conclusion, to suggest an equalising arrangement in which the drop of potential in the equaliser is divided equally among the machines, in consequence of which the currents in the series windings of all the machines are equal under all conditions. The arrangement is shown in figs. 6 and 7.

It will be seen that this is accomplished by connecting the beginnings of all of the series coils to an extra bus bar, to which is connected also one brush of each machine, instead of connecting the series windings direct to the brushes and the junctions of these to the equalising bus bar, as in Gramme's method.

By arranging the connections in this manner it is evident that the currents in the series coils of the machines will, at all times, be proportional to the capacities of the machines, provided the resistances are proportioned in such a way that the drop of potential from the brushes of all the machines to the bus bars will be the same at full load.

Fig. 6 shows how this method would be arranged at the switchboard. The mode of operation would be as follows: Whenever it is desired to throw in an additional machine the single pole switch is first closed. This completes the series field circuit, and we immediately have a current in the series coils of the new machine, which will be proportional to its capacity. The rheostat in the shunt circuit is then adjusted until the new machine generates the desired E.M.F. After this is done the main switch may be closed without producing any further disturbance in the E.M.F. of the system.

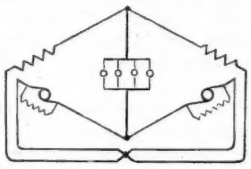


Fig. 7.

While this system does not equalise the currents in the armatures, it does equalise those in the series coils, an effect which is only partially accomplished in the first-mentioned system. Moreover, it is applicable to any number of generators of equal or of different capacities, and in no way interferes with the continuity of operation, while the throwing in or out of additional units is greatly facilitated.

It has these disadvantages, however: It necessitates an additional conductor from the dynamo to the switchboard, and, moreover, the full current passes through the conductors which here replace the equaliser. Hence, the first cost is somewhat increased, and, further, a certain amount of energy is lost in heating the conductors. In very large installations, where the distance between dynamos and switchboard is considerable, and where the currents are of great magnitude, the loss of energy which this method involves may be sufficient to preclude its application. In smaller installations, however, the increase in first cost and the loss of energy in the additional conductors will be inappreciable.

BOILERS FOR CENTRAL STATIONS.

It will be a long time before actual experience will be likely to show finality in the exact type of boiler to be adopted for central stations. While some engineers advocate the employment of the cylindrical system, others, as we know well, adhere to the water tube style for generating their steam. But as there is not unanimity over the question, and the conditions are broadly the same, we may ask how much sentiment is answerable for a preference one way or the other. We know that the economy on the whole cannot be widely different in the two cases, because accounts are closely criticised nowadays, and extra expenditure therefore noted. Still it would not be fair to judge solely by a comparison of water evaporated per pound of coal alone without reckoning the station charges altogether. Time is therefore likely to elapse, if ever the case at all, before we may expect to find the practice at stations generally agreeing on this point. It is not, however, without interest to weigh the *pros* and *cons* bearing upon each side of the matter, though even then we may not be able to predict with certainty what the future is to be as far as this question is concerned.

As from the nature of the case, electric stations are situated more often than not in crowded districts, an important feature in favour of the water tube boiler is the facility with

which it may be split up and put together in confined spaces. This means cheaper transit to begin with, owing to the smallness of the loads carried, less room taken up, and therefore area charged for, and possibility of being adopted from its compactness and sectional construction where no other boiler could be got in at all. It is very common in towns to see Lancashire boilers put down in a building at the same time as the foundations, because the plans do not permit of this being done conveniently later on. With water tube boilers, however, the same consideration is not necessary, because with a restricted opening left they may generally be lowered into the basement whatever the time of delivery. This quality of handiness is, therefore, one which though it would not appear in the accounts directly, yet to an engineer counting the costs and drawbacks attending upon getting heavy weights into place would mean a saving in other ways. The lightness for horse-power of the water tube type means, apart from compactness and cheapness of handling, less standing charge for space occupied, and due to all causes probably there is a saving here which if it were well looked after would in the aggregate be of no small importance. In any of our large cities with a battery of boilers and a high rent charge there might be a considerable margin under this head alone, and which would moreover be a constant source of profit. In this connection also notice should be taken of the fact that with higher pressures in the water tube boiler the engine is smaller for given work. This signifies, therefore, a reduced initial cost in favour of the system, and that the engine department is affected in the way of weight and handiness much the same as the boiler. The ability to raise steam quickly, though of value in electric installations, is perhaps not so important as the opportunity the water tube boiler affords for dividing the power into smaller portions. As the demand increases, therefore successive increments of steam producing capacity may be set to work, and at short notice; whereas in the case of a fog coming on suddenly, this is necessary. In the same way fires may be withdrawn, and the boiler cooled down and removed from service with equal facility, supposing repairs or cleaning desirable in a hurry. A smaller reserve of power for actual work accomplished can therefore be provided for than would otherwise be the case.

When we come to the rate of evaporation, there is perhaps not so much to be said. From the time of lighting fires from cold water, to that at which steam is available, may be a short interval; but with full pressure attained, do we find an equal amount generated from a given quantity of water with the same consumption of coal. Here opinions differ, but the general tendency leans to the tank class of boiler in this particular. The body of water being so much greater in the latter case, when a start is once made the heat of the fire obtains more the mastery over the work it has to do, with a proportionate conservation of calorific energy. Each particle acts and reacts on the other to the benefit of the whole, and the boiler being internally fired to begin with, the heat is better accumulated, and is not able to escape in the way it can under the externally fired system. Be this as it may, the consensus of opinion favours the cylindrical boiler here. Figures would be out of place, because similar careful conditions of trial and design can seldom be obtained, even of two boilers of the same type, but the conclusion is indisputable, and assuming this to be so, the saving would be constantly shown in the coal bills. An advantage of having the greater reserve of power in the one case is that the same careful attention is not required on the part of the stoker, the boiler more or less taking care of itself. Indirectly, this may be an economy in wages, because fewer men would be wanted in a large installation, or in a small one the man becomes free for other duties.

Generally, therefore, we see that much is to be said for both sides of the matter, and that though individual engineers may have their predelictions for the type they adopt, there are broad lines ready drawn for their guidance. If, for example, the site selected for a station gave plenty of land which had been purchased outright, with, therefore, all the plant on the ground level, then slow-running engines fed by Lancashire boilers might be a very proper way of meeting the demand. In case of emergency, fires could be kept banked in the spare boilers, to meet any rush for power; and in such an installation the repairs would be likely to be light, if care were exercised in the original design. The plant would be a lasting one, and little risk incurred of breakdowns. On the other hand, if the opposite conditions prevailed, and the station were situated in narrow streets, and of small dimensions on more than one floor, then it would seem to be expedient that the water tube system should be put down. Acquaintance with the one form of boiler is of little value in dealing with the other, but the above seems to sum up what may be said for and against both. The economy shown under any particular heading cannot of necessity embrace the whole of the features bearing upon the question. To do this, two towns with the same number of lights must be found, and beginning with rent, the costs taken from the contractors supplying each plant down to the coal, wages and sundries; but the great difficulty of obtaining all the items with anything like exactitude would, we fear, make the standing current charge for each light unit so arrived at, of such problematical value that few would be inclined to put great faith in the figures. Even then there would still remain certain elements which could not be reckoned at all. Some of these we have endeavoured to specify, but others of minor importance will suggest themselves to engineers accustomed to either mode of working. On the whole, therefore, we may expect to find that the issue will remain an unsolved one, local conditions having a determining influence on the matter, and when, as is the exception, there is an open field presented for the employment of either of the two, those responsible for the selection may very well find the absence of any complete reliable data an excuse for recommending the particular class of plant with which they are the more familiar.

MAGNETIC BRAKE METERS.

Mr. George Hookham has good reason to feel satisfied with the legal victory he has won in the Law Courts, a result which is to be attributed to far-seeing and painstaking technical work, quite as much as forensic eloquence. Although not an electrical engineer alone, he has done yeoman service in this field. By the qualification we mean nothing derogatory to Mr. Hookham—rather the reverse—but everyone may not be aware that this gentleman amuses his friends by a mere mention of the industries and processes with which he has, or has had, something to do. We believe that so trivial but useful an article as picture cord is not below his notice; and why should it be, when many hundred of yards are sold for every electric meter, while, if our memory serves aright, there is to be found something intimately connected with the lace manufacturing industry that also originated in his fertile brain. Assisted by an able staff at Birmingham—and the name of S. H. Holden cannot be overlooked in a reference to this—the firm of Chamberlain & Hookham have brought out probably more types of meters than any other business house. Indeed, their very fertility is sometimes liable to nonplus their clients, for we have heard engineers remark that no two batches of Hookham meters are ever despatched in which the details remain the same.

Mr. Hookham has, however, done something more than devise meters. His experimental investigations and clear enunciation of the law governing permanency in permanent magnetic circuits, as set forth in his contribution to the *Philosophical Magazine* some years ago, showed that the laboratory and the workshop have equal importance in his eyes. The different forms of continuous and alternating meters to which his name is attached have been so fully described in our columns, that they must be well known to even those of our readers who have not had the advantage of practical acquaintance with them, and considering the number of such meters now in use, there are few central station engineers who lack abundant facilities in this respect. One type has not, however, survived; this was a meter very similar in principle to the Elihu Thomson energy meter. A horizontal arbor carried a fine wire ball armature provided with a mercury commutator rotating in a heavy wire coil surrounding it, and further along the shaft was a magnetic brake formed by a vertical copper disc rotating within the air gap of a couple of horse-shoe magnets. This form was the subject of experiments so long ago as 1890. Since then we have had brought out the Ferraris motor alternating current meter,

and it is curious to note that there are now three meters on the market possessing a Ferraris motor as the driving power and a Foucault disc as magnetic brake, these being the Hookham alternating "energy" meter (giving units on approximately non-inductive load), the Shallenberger integrating wattmeter of the Westinghouse Company, and the Hümmel "energy" meter (which, by-the-bye, gives remarkably good results on inductive loads). The Hartmann and Braun continuous current meter included a continuous copper disc, in which the current travelled from the axis to the periphery, the contacts being made by mercury cups, and one large electromagnet excited in parallel with the lamps produced the field, which created both driving and braking force. Even this type seems to have been foreshadowed by Mr. Hookham in his 1887 patent.

The cause recently heard before Mr. Justice Wills in the Queen's Bench Division of the High Court of Justice, although ostensibly bearing upon the whole of the claims of the 1887 patent as amended, virtually resolves itself into a question whether the application of a magnetic brake in electricity supply meters may be utilised by anyone or if it be the property—because it is the invention—of the plaintiffs. In the judgment, which is on the whole correct in phraseology, it is held that drawings accompanying the specification of the patent are intended to give a perfectly definite description of one form of apparatus and to illustrate the principle and method of combining an electromotor and a brake in a constant (but not uniform) field. To this is added, "preferably both using the same field." This limitation obviously excludes alternating current meters, but being only an expression of opinion it does not interfere with the remaining portion of the claim. Next, the combination of the brake is to be with an electromotor of any of the ordinary forms in use, and in the judgment this was interpreted, "the application of this combination to all ordinary forms of electromotors is clearly within the claim."

It is, therefore, beyond question that the magnetic brake principle was the *casus belli*. Putting it generally the other claims concerned a meter in which the driving force was large, and the brake powerful and constant, bearing friction and windage being first of all reduced by a minimum by special devices, and, secondly, caused to be negligible compared with the driving and braking forces. From the type of meter patented in 1887, manufactured in 1888, and exhibited at the Institution of Electrical Engineers, May 30th, 1889, to present patterns is a long step, but the magnetic brake and its appurtenances form the connecting link, and Mr. Hookham has obtained credit for the merit attached to their design.

REVIEWS.

Power Distribution for Electric Railroads. By Louis Bell. Ph.D. New York: Street Railway Publishing Company,

(Concluded from page 543.)

Dr Bell ventures to recommend under certain conditions the use of voltages higher than 500! but we fear it will be some time yet before the Board of Trade sanctions 750 volts, even for interurban work.

In chapter V., he deals with the subject of sub-stations, and shows them to be mainly of three kinds: (1) Auxiliary stations to one main station, for the supply of distant districts. 2. Separate stations supplying consecutive parts of a line or network; and 3. Pure sub-stations in connection with, and worked from, a central station. The first kind are found in large centres where a network has grown so much that it can only be dealt with by auxiliaries to the main power-house, but each complete in itself. The second class includes the distributed stations over a long line, each supplying a given section. The third class, or sub-stations proper, involve power transmission from the central supply station, by the use of motor generators or their equivalent. The concrete consideration of instances of each type constitutes the author's sole digression into mere descriptive writing; but as the examples are of recent practice, and each one is enlarged upon in theory, Dr. Bell is to be congratulated, rather than blamed, for venturing upon "pictures and plans." We quote a couple of extracts with which we heartily agree:—"The choice of compound instead of triple expansion engines was probably a wise once, since while the latter are a trifle more economical at full load, they are less able to cope efficiently with great variations of load, such as are met in railway work." "Almost the only question that could be raised would be the desirability of using vertical marine type engines, which are of equally high efficiency, slightly higher speed, and take up much less floor space."

The composite machines on the Akron, Bedford and Cleveland road are discussed, but Dr. Bell does not say how far, if at all, any effort is made to compound these generators which deliver both 500-volt continuous current on the railway and 380-volt alternating for glow lamps, &c. It hardly seems likely that they are self-regulating for both loads.

Chapter VI., dealing mainly with the several methods and principles of an alternating supply at high pressure to sub-stations, is extremely well written, and serviceable even to the engineer of advanced experience in traction systems. When touching upon the question of transformers, Dr. Bell is, however, perhaps too rash in recommending the use of oil as a heat radiator for these appliances; it has for some time past been averred that after a short interval of use, certain oils become a source of danger in regard to the transformer insulation, rather than a means of safety. Air cooling by means of a small fan is much to be preferred for reducing the heat developed in these appliances. A single horse-power is enough for cooling several hundred kilowatt transformers. The weight of these latter should run to 20—25 lbs. per kilowatt output, and the efficiency at full load 98 per cent. says Dr. Bell. Pole lines for high pressure transmission are next discussed, and here again the author recommends oil insulation, though it is not adopted on the Niagara-Buffalo line lately opened, nor should we think it necessary anywhere under ordinary conditions. Synchronous alternating motors are usually started, says the author, by a small induction motor, which brings the large one up to speed and is then switched out, the load being put on through a clutch; this device strongly resembles the barring engine usually employed in cotton mills, &c., for starting the main engines. Polyphase motors are, however, preferable in most cases.

Dr. Bell devotes the next chapter to a treatment of alternating motors for traction work: these he divides into four classes—First, synchronous motors, started by commutation, a good example of which is the double wound armature machine, lately developed by the Fort Wayne Company. One of these windings is for ordinary monophase current, in slots on the armature core; the other, a continuous current drum winding connected to a commutator. The machine starts as an ordinary series motor, the commutator serving to rectify the alternating current. When at speed, the alternating current is thrown over to the inner winding, and the outer gives exciting current from the commutator. This machine starts under normal load with 50 per cent. more current than that required for the same torque when running in synchronism. Secondly, there are the synchronous machines started as induction motors, which do not start well, and cannot be varied in speed when running in synchronism. Third, asynchronous polyphase motors, as now in operation at Lugano, for instance. The weak points of this type are two—1, the necessity for two trolley wires; and 2, lagging current; but Dr. Bell thinks that in heavy long distance work and fast interurban service there is a great field for development in polyphase work. Fourth, there are the asynchronous monophase motors—either true polyphase motors worked by derived polyphase currents obtained by splitting up a monophase current, or else employing a split phase current at starting to obtain a simultaneous transformer and motor action, though purely monophase when running.

Dr. Bell sums up the present condition of alternating current work by saying that the only motors really suitable now for railway service are those of the polyphase induction type. Synchronous motors, both monophase and polyphase, have excellent properties when up to speed, but do not start well except at the cost of complications.

Chapter VIII. is taken up with discussions as to the underlying principles of interurban and cross country lines, a class of electric railway which we are hardly in sight of as yet in this country. It will take us many years to reach an advanced point in ordinary tramway work, so far as extent

goes; and it is to be feared that Dr. Bell's work will not, in this respect, be of much avail to English engineers; more's the pity. He again urges the importance of condensing, and in most cases of using compound engines; belting or direct coupling depends on the size of unit, the boundary between the two lying at about 250 H.P. or so. All above this output are usually best direct coupled; below it belting is preferable in the majority of cases. The questions of capacity required in feeders, &c., are all calculated out most carefully by Dr. Bell for various conditions, and his methods, if followed out, ought to effect a great saving for every line built by the up-to-date engineer. He thinks that a narrow gauge electric line, say, 10 miles long, can be built and equipped all ready for service at a cost of £1,200 per mile only, no allowance, of course, being made for land, &c., whilst the total daily train mileage is reckoned at about 160.

The last chapter deals with the problems of fast and heavy railway service, and, of course, can only be of a hypothetical nature. Nevertheless, Dr. Bell discusses the question with sound common sense, based on reliable figures as to what is essential for such work, and the results are not only of great interest, but also extremely promising. He does not scruple to figure out the power required to drive a given train continuously at 100 miles an hour (inventing a word—"exterpolate"—on the way); but it is done in no visionary manner, and no conservative engineer could with fairness quarrel with it. Dr. Bell considers, of course, that only an alternating supply could be used, with transformers carried upon the cars or train. The whole question turns upon the value of time; if business men and others will pay higher fares to gain an extra hour or two, there seems no reason why high speed train service should not be a thing of the *very* early future. Descriptions and discussions of electric traction applied to elevated railroads and such special services as long tunnels, &c., where coal burning locomotives are an intolerable nuisance, fill the remaining pages of what is to our mind the best book upon electric traction methods yet published, and likely to remain so until a second edition appears.

THE PRODUCTION OF X RAYS OF DIFFERENT PENETRATIVE VALUES.*

By A. A. C. SWINTON. Communicated by Lord KELVIN.

As is well known, if the X rays coming from an ordinary Crookes tube of the Jackson focus type be observed with a fluorescent screen during the process of exhaustion, the penetrative value of the rays is found to change as the exhaustion proceeds.

First of all, at less than a certain degree of vacuum, no X rays are produced. Next, as the vacuum is increased, X rays commence to show themselves, but of a quality that will do little more than penetrate the backing of the screen. As the vacuum is further increased, the rays become more penetrative, and show the shadow of the bones in the hand. As exhaustion proceeds further, a point is reached when the flesh of the hand seems to be almost completely transparent, while the bones are almost entirely opaque. At higher vacua than this, the bones becoming more and more transparent, the contrast between bones and flesh becomes less and less, till at length, at the very highest vacuum at which the discharge will pass, the bones scarcely show at all, owing to their having become nearly as transparent as the flesh, while the whole hand throws but a very faint shadow on the screen.

Similarly, it is found that at any given degree of vacuum the penetrative value of the X rays is increased by increasing the power of the Ruhmkorff coil, and thereby increasing the difference of the electrical potential between the cathode and the anode portions of the tube, as measured by the length of the alternative spark in air.

Again, similar results are obtained without alteration to the vacuum or to the power of the Ruhmkorff coil by varying the resistance of the tube by means of a magnetic field.*

In this case the gradual strengthening of the magnetic field produces a gradual decrease in the resistance of the tube, and of the difference of the electrical potential between the cathode and anode, and, at the same time, causes a gradual diminution of the penetrative value of the X rays.

I have further found that it is possible to vary the penetrative value of the X rays produced in a focus tube by simply altering the distance between the cathode and the anti-cathode.

For this experiment the tube, fig. 1, was constructed, in which the anti-cathode, B, of aluminium, faced with platinum, is connected to the anode terminal by a sliding steel rod, so that it could be moved along the axis of the tube, and the distance between cathode, C, and centre of the anti-cathode, B, varied from 1 to 3 inches, the anti-cathode being always outside the focus of the cathode. The tube was exhausted to a degree that gave a maximum contrast between the bones and flesh of the hand when the anti-cathode was midway between its two extreme positions, and was then sealed off, so that the vacuum was not varied during subsequent experiments. Upon the anti-cathode being approached to the cathode, the X rays

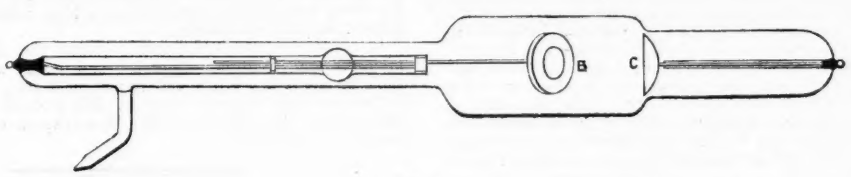


Fig. 1.

immediately became of a more penetrative value, just as though the vacuum had been increased, while at the same time the potential difference, as measured by the alternative spark, was found to have risen. Again, when the anti-cathode was moved in the opposite direction, and placed at a greater distance from the cathode, the potential difference fell, and the X rays became less penetrative, and similar to those produced at a lower vacuum. In this way, without varying the vacuum, the penetrative value of the X rays could be increased or decreased as desired within the limits of the focus on the one hand, and the travel of the anti-cathode on the other.

Again, I have found that the penetrative value of the X rays can be altered by employing cathodes of different diameters.

Having noticed that focus tubes with small cathodes give X rays of any given penetrative value at a much lower exhaustion than do exactly similar tubes having cathodes of larger diameter, the tube fig. 2, was constructed, in which there are two cathodes, C and C' both focussing upon opposite sides of the same platinum anti-cathode' B. The two cathodes were of dissimilar diameter, C being 0·375 inch diameter, and C' 1·125 inch diameter. Both had the same radius of curvature, namely, 0·75 inch.

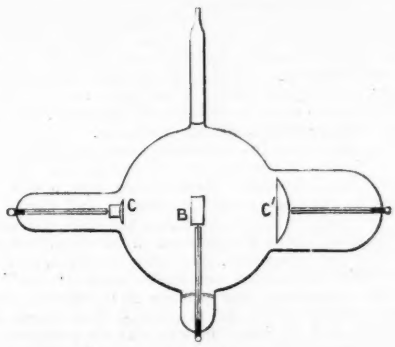


Fig. 2.

On exhausting this tube with the smaller cathode, C, in use, and the other not connected, a degree of vacuum was soon reached when X rays began to be produced plentifully. Pumping was then suspended, and the negative connection changed from the smaller cathode, C, to the larger, C'. Under these conditions, no X rays could be obtained, the vacuum being evidently much too low for the larger cathode. On continuing the exhaustion to the point when, with the larger cathode in operation, X rays were produced, but of a low penetrative value, the negative connection was removed from the larger cathode, and the smaller cathode put into use. Immediately it was found that the penetrative value of the X rays had increased to an extent that could only be obtained with the larger cathode with a very much higher vacuum.

Throughout the experiments with this tube it was further found that the potential difference, as measured by the alternative spark in

* Received March 24th. Read before the Royal Society, April 8th, 1897.

* See "The Effects of a Strong Magnetic Field upon Electric Discharges *in Vacuo*," Roy. Soc. *Proc.*, Vol. 60, p. 179, and note in *Nature* for July 9th, 1896, p. 239.

air, was much greater when the small cathode was in use than with the larger cathode.

The penetrative value of the X rays produced by any given tube appears, therefore, to be dependent upon several conditions.

1. The penetrative value is higher for a high vacuum than for a low vacuum.

2. It is higher when the electrical power applied is great than when it is small.

3. It is higher when the resistance of the tube is great than when this resistance is reduced by magnetic means.

4. It is higher when the distance between the cathode and anti-cathode is small than when the distance is great.

5. It is higher when the cathode itself is small than when it is large.

6. It is higher when, as a consequence of one or more of the above, the potential difference between the cathode and the anode portion of the tube, and consequently the electrical excitation of the cathode is great than when it is small.

On the assumption that the cathode rays consist of negatively charged molecules that are repelled from the similarly electrified cathode with an initial velocity that depends upon the degree of electrical excitation of the cathode, the above conditions are those that would conduce to a high average velocity of the molecules at the moment at which they strike upon the anti-cathode, and, at the same time, to a high average difference of potential between the travelling molecules and the anti-cathode at the moment of impact.

At high exhaustions, not only is the electrical excitation more, and the initial velocity of the molecules consequently greater, but, owing to the smaller number of collisions with the other molecules of residual gas in the tube, the average velocity of the molecules and the amount of their negative charge have suffered less diminution by the time they reach the anti-cathode than in the case of lower exhaustions.

Similarly, when more electrical power is employed, the electrical excitation and the initial velocity of the molecules is increased, while the employment of a magnetic field reduces the resistance and the electrical excitation, and consequently reduces the initial velocity and negative charge of the molecules.

Again, when the anti-cathode is near to the cathode, the moving molecules having a less distance to travel before they reach the anti-cathode, have by that time lost less of their initial velocity and charge by collisions than when the anti-cathode and cathode are further apart.

And, lastly, not only does a small cathode become charged to a higher electrical potential than a large one, and consequently impart a higher initial velocity and charge to the molecules, but with a small cathode the travelling molecules are more compactly arranged than with a large cathode, and consequently are not likely to make so many collisions and lose so much in velocity or electrical charge during their transit.

It would, therefore, appear that, whatever the precise cause, the penetrative value of the X rays produced under any given set of conditions is dependent upon the average velocity of the molecules and the difference of potential between them and the anti-cathode at the moment of impact, being higher the higher the velocity and the greater the potential difference.

Further, since the excitation of the cathode is not uniform, but varying, so that different molecules have different initial velocities and charges imparted to them, and since some of the molecules will make fewer collisions than others, and some molecules will thus strike the anti-cathode at higher velocities and in a more highly charged state than others, the same hypothesis will account for X rays being more or less heterogeneous under all conditions.

Finally, it appears that the penetrative value, as distinct from the quantity, of X rays is independent of the material of which the anti-cathode surface is made. Experiments with a tube in which the anti-cathode was made partly of platinum and partly of aluminium, and so arranged that, by inclining the tube, the anti-cathode could be moved, and either the platinum or the aluminium part could be brought into use, show that, even with metals having such very dissimilar atomic weights, the penetrative value of the X rays produced was the same, though the quantity of the rays as measured by photographic action, or by the brightness of a screen of barium platino-cyanide, was distinctly greater with the platinum. Further experiments with other tubes fitted with anti-cathodes of aluminium, iron, copper, silver, and platinum, confirm these results. The metals of high atomic weight form the most efficient anti-cathodes, and give a larger quantity of X rays, though the difference is not so great as might, perhaps, be expected. All, however, appear to give X rays of the same penetrative value under similar conditions.

I am indebted to the assistance of Mr. J. C. M. Stanton and of Mr. H. L. Tyson Wolff for the exhaustion and manufacture of the various tubes with which the above experiments have been made.

THE SOCIÉTÉ INTERNATIONALE DES ELECTRICIENS.

The general meeting of this society was held on April 7th, 1897, M. G. Sciama taking the chair. The fresh elections took place, with the following results: President for the season 1998-99, M. R. V. Picou; vice-presidents, Messrs. Hillairet and Pollard; secretaries, Messrs. Aliamet, Brunswick, and Loppé; general secretary, M. Gosselin; members, Messrs. Arnoux, Bernheim, Bochet, Bonfante, Bonneau, de Bovet, Brauly, Claude, Clérac, Darig, Javaux, Leblanc, Le Chatelier, Pellissier, Rechniewski, Sartiaux, Viullemeier, Walckenaer. The reports presented by the committee of accounts were read and approved.

M. Hillairet, the general secretary, read his report and reviewed the principal events of the year.

M. Pellat first read a paper on the decimalisation of the hour in France, and showed how the C.G.S. system would be affected if the proposals of a committee now sitting were accepted. It was decided that the Society should consider the question and address a letter to the Government.

Dr. D'Arsonval then read a paper on "The Physiological and Therapeutic Action of High Frequency Currents." He first referred to and demonstrated the powerful induction effects that can be obtained with these currents. He performed a striking experiment by placing three lamps in series and making the current pass through his body. These currents exercise no action on the nerves or the sensibility generally, and a man placed in a solenoid only knows that he is being subjected to these currents when he sees a signal lamp beside him light up. The principal results of this treatment are increased oxidisation in the system, and an increase in the production of heat. A patient who, under ordinary conditions, gives off 17 to 21 litres of carbonic acid per hour, gives off 37 litres after having been subjected to this treatment. The high frequency currents act not only on the surface of the body but also internally. All these results were observed on a large number of patients by Messrs. Apostoli and Charrin.

In conclusion, Dr. D'Arsonval quoted the action exercised on microbes and bacteria. Microbes and bacilli are modified. The toxic elements are killed and transformed into vaccines. Messrs. D'Arsonval and Charrin hope by this method to treat microbic diseases directly within the body. Some experiments with this object are now being tried.

THE ELECTRICAL INDUSTRY AT NEWCASTLE.

It is to be feared that dwellers in the metropolis have become callous regarding exhibitions where things are exhibited. Exhibitions, however, which are devoted to entertainment and not to instruction, Earl's Court, to wit, appeal to most of us, and quite a limited knowledge of the enjoyment obtained from such places spoils one for the exhibition pure and simple. We believe there are exhibitions held regularly in the North of London that are devoted entirely to showing the products of different industries; whether they ever interest the general public is doubtful, but they probably serve as a fairly serviceable sort of market. In a provincial town, however, where certain well-known industries abound, the reasons for an exhibition are perhaps more weighty than they would be in London. At any rate, the inhabitants of such a town would be closely in touch with any industry whose productions were to form an exhibition, and might therefore be expected to show their sympathy by their presence.

Having come to regard exhibitions with the eyes of a Londoner, it was with a slight sense of doing a noble duty that we set out to view an aggregation of plant and materials known as the Newcastle-upon-Tyne Electrical and General Exhibition. It need hardly be observed that the exhibition has certain definite objects—we never knew one that had not—and they are, to bring "before manufacturers and the public the latest developments and appliances of engineering and electrical discoveries." In addition to this ambitious task the promoters hope that it will serve as a fitting commemoration of the sixtieth year of the illustrious reign, &c. The character of the exhibition is a most cosmopolitan one; there are grouped under one roof some excellent and interesting examples of the applications of electric motors, and there is a decorative stand in which Van Houten's pure soluble cocoa is served by the cup in order that visitors may judge that it is not only "the best" but "goes farthest." We did not try the "pure soluble," but we saw a good many people with sad faces. Then there are some well known types of steam engines, dynamos, electric pumps, gas engines, "exhibition tea" at 2s. 4d. per pound, and amongst other engineering novelties are Andrews's liver salt and golden syrup in tins.

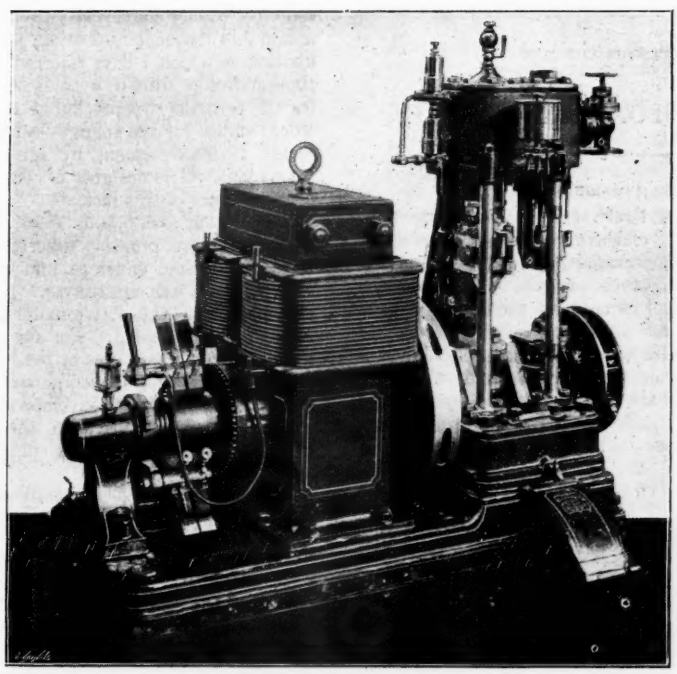
In a local exhibition incongruity could not well be avoided, and if the cycling industry is a little prominent and the odour from the manufacturing confectioners' stalls inclined to make one feel tired, there is no doubt that from an engineering point of view the collection of plant is most interesting. There is an abundant display of electrical machinery, and the most creditable feature is that most of it is made in Newcastle. Most electrical men are aware that the Northumberland town is a strong centre of the electrical industry, but unless they are well acquainted with the district they can have no conception of the strength of the electrical industry in that

locality. To mention the names of Messrs. Clarke, Chapman and Co., Limited, J. H. Holmes & Co., Ernest Scott and Mountain, the Sunbeam Lamp Company, is sufficient to show that electrical engineering in the north has become a local industry of considerable dimensions, and when we note the new firms there is little doubt that there will be still further developments.

We propose to do more than merely note the varieties of plant at the exhibition, and to widen the scope of this and subsequent articles, we shall refer to some of the electrical works that exist in the neighbourhood of Newcastle, as well as to note some of the principal types of machinery that are turned out here.

One of the youngest electrical firms in the Newcastle district is the Sunderland Forge and Engineering Company, Limited. Needless to say, this firm is represented at the exhibition, and among their principal exhibits are two small combined plants specially built for ship lighting, and a dynamo constructed for driving by gas engine, and having an extended bedplate, extra bearing, and heavy fly-wheel. The ship lighting plant is a very prominent feature on this company's stand.

The larger combined plant consists of a compound-wound dynamo with ring armature, capable of giving an output of 110 amperes at an E.M.F. of 65 volts, when running at a speed of 325 revolutions per minute; this is coupled direct to a high speed inverted vertical open-type engine of the firm's own make, which is specially designed and constructed for driving dynamos on shipboard. This engine is built to stand a working pressure of from 160 to 200 lbs. per square inch, and every care is taken to ensure cool running, the bearings in all cases being of ample size, and easily adjustable. A special lubricating arrangement is also fitted, which enables all working parts being thoroughly oiled whilst the engine is running.



Combined Plant Manufactured by the Sunderland Forge and Engineering Co., Ltd.

The smaller plant, which is fitted with a drum armature of special construction, has an output of 60 amperes at an E.M.F. of 65 volts, when running at a speed of 400 revolutions per minute. This plant has similar advantages to the larger one, the dynamo being compound wound, and special care being taken with all bearings and ensured lubrication whilst running.

The engines are also fitted with carefully-balanced crankshafts, and every care is taken to ensure perfect balance in the armatures, thereby reducing vibration to a minimum.

The ship lighting plants are fitted with automatic cut-off governors.

Among the other exhibits of this firm may be mentioned two crane motors, of 4½ B.H.P. and 2 B.H.P. respectively, an improved ship lighting switchboard, which is fitted with two 50-ampere double pole switches with double pole fuses, and four 25-ampere single pole switches with single pole fuses, and a marine type voltmeter reading to 80 volts, the whole being mounted on an enamelled slate base, and mounted in a heavy oak frame. The switches are of the knife pattern, and they and the connectors are all of copper.

There is also a small drum armature, with a special improved system of winding.

Among the specialities manufactured by the above firm may be mentioned all classes of double acting high speed engines, either single cylinder, compound or triple expansion, both open and enclosed self-lubricating types. Combined plants for ship lighting, and all the necessary details for this class of work, including switchboards and projectors. Central station plants both for continuous and alternating currents, switchboards and transformers.

The firm also make a speciality of transmission of power by electricity in all its branches, including electric three motor cranes, hoists, fans, pumps, and haulage plant for collieries, and the adapting of motors to all classes of machinery.

In their engineering department the work includes feed, fire and bilge pumps, air and circulating pumps, condensers, forced draught fans, ventilating fans, high speed double acting fan engines, and all classes of ships' auxiliary machinery.

In the forge department the firm turns out about 150 tons of forgings monthly, principally ship and engine work, *i.e.*, stern frames, rudder frames, shafting, &c.

Not the least interesting exhibit is that of the Sunbeam Lamp Company, Limited, of Gateshead-on-Tyne, who have a good display of electric incandescent lamps of every imaginable variety.

Naturally the display is a brilliant one, and though nothing else but lamps are shown, the different varieties repays some close attention.

There is a class of lamp in particular which cannot fail to attract attention, as it is certainly an excellent piece of workmanship. We refer to the huge lamps of 2,000 to 3,000 C.P.

The globe of these lamps measures about 10½ inches in diameter, and four filaments are used in its construction.

The current consumed is about 50 amperes, and from this one may judge of the size of this particular lamp. It goes without saying that the firm has long been renowned for their high C.P. lamps of every size. These large lamps are ordinarily made in the efficiency of 2 watts per C.P., and if a little longer life is required irrespective of current consumed, the lamps are then made of 2½ watts efficiency.

The principal sales we learn, however, are of lamps from 500 C.P. downwards, for which there is a very great demand, and still this seems to be on the increase.

It is the firm opinion of the makers and of the managing director, Mr. J. W. Edmundson, that these high C.P. lamps are certainly more economical for lighting large areas, and from their own experience, are very much more effective, as far as light is concerned, than using groups of small lamps, and, though they consume much more current than are lamps, they would probably under many conditions be preferable. The lamps for high voltage circuits were, of course, much in evidence.

In conversation with Mr. Edmundson, we learnt that whilst there were many inquiries for these high voltage lamps, yet the ordinary type of lamp was still considerably in the ascendant.

He was, however, quite prepared to meet the requirements of any market, and showed to us one lamp for 230-volt circuit, and made with a single filament. This would be serviceable where the lamp was hung in a perpendicular

position, but owing to the long and thin filament it would be impossible to incline it at any angle. To meet this, however, we were shown another lamp in which two filaments were used of somewhat stouter and, of course, shorter filament, which could be run in any position whatever. From tests made with these lamps the results have been very satisfactory, but of course there is much more trouble in the manufacturing, and it is therefore impossible to put them on the market at the same price as the ordinary type of incandescent lamp.

There are also exhibited various fine vacuum tubes which are interesting.

We note also that this company manufacture very successful focus tubes for X ray work, and have a special arrangement at the exhibition for showing these tubes. We were greatly interested in an inspection of the works which we were permitted to make by the kindness of the managing director, Mr. Edmundson, and the company seems to be in a flourishing condition, inasmuch as they are at present contemplating further extensions to their large works, which they have been compelled twice to do since the beginning of their manufacture of small lamps.

CORRESPONDENCE.

The Ribbe Accumulator.

I must confess to a very lively sympathy with any well-intentioned and *bonâ fide* endeavour to solve the great problem of the storage of electrical energy for automotric traction, even when such endeavours may be based upon more or less mistaken views. I should be inclined to insist very strongly that no honest and single-minded workers—whether from France, Germany, America or Japan—should be discouraged from entering a field which, to so great an extent, is already occupied by blatant ignorance and brazen impudence. In this field the electro-chemist—he whose aid is indispensable for the ultimate solution of the problem—is conspicuous mainly by his absence; in effect he is told that he is not wanted, and he holds himself and his "laboratory results" in the background. Until new order—as the French say—knowledge of the question in its various bearings is to be obtained only by the careful study of the appliances which, with little encouragement beyond that to be derived from the enthusiasm and perseverance of the inventors, are from time to time brought forward for the consideration of practical men.

As a matter of fact, the Ribbe accumulator, though the "prentice han'" is clearly visible in some of the details of its construction, differs in some important respects from any appliance of this kind that has heretofore been subjected to experimental trial on a practical scale. Making comparisons where these are possible, the main points of difference relate to the connection or "keying" together, at frequent points, of the enveloping celluloid ribs, and in the comparatively low density of the current, with any given ratio of amperes to weight of accumulator. This question of density, involving the permanency of the initial working conditions of the cell, is one of great practical moment, as will be sufficiently evident when it is considered that the ampere current liberates per hour, at the surface of the peroxide plate a quantity of hydrogen which, if not absorbed, would occupy a space of over 25 cubic inches. When the current density is low, absorption readily takes place; but when, as in some recent forms of traction-battery, the density of current and the ratio of active material to metallic surface are enormously high, the initial working conditions may be ruinously modified in consequence of the evolution of hydrogen in the gaseous form. Unfortunately, in the Ribbe accumulator as at present constructed, although the mean density is low, the density of the current, both of discharge and of charge, varies within wide limits at various portions of the plate. I think that it would not be very difficult to show during the charge that oxygen gas may actually be evolved from the upper portion of a peroxide plate long before the lower portion is fully charged; and that conversely, during the discharge, the upper portion of a plate may be heavily sulphated before the lower portion is discharged to the normal extent. This condition of things prevails in all accumulators when—as is almost necessarily the case in traction cells—the supports are of thin sheet lead; and when, moreover, the conductivity of the supports is further diminished by perforations, and the supports themselves are of considerable altitude. The remedy may be found in a system of multiple contacts, in which the plate is divided into squares of 3 or 4 inches side, each of which is discharged by a separate conductor.

But although this device will steady and regulate charge and discharge, and allow of a considerable augmentation of the rate in either case, it affords no remedy for the corrosion of the peroxide support by local action between it and the active material. In the accumulator shown at the Deptford Tramway depôt on the 6th inst, the great mistake was made of having supports of equal thickness for the peroxide and the spongy-lead plates. And this thickness is only 35 mils. Unless one of the newly-devised methods for rendering a thin lead anode indestructible can be applied in this case, the peroxide element would be of very small durability. It would soon be wholly converted into peroxide by continuous local action and frequent re-charge; and the difficulty as to conduction to which I have referred would then be augmented a thousandfold. But if a thickness of 35 mils be sufficient for the peroxide support, surely that of 25 or even 20 mils would suffice for the spongy-lead support, which, unless subjected to maltreatment by ignorant hands, is absolutely permanent. The designer of the cell would appear to have been unaware of this fact.

The Patent No. 5,506, 1896, for the Ribbe accumulator would be more properly described as one for a particular form of celluloid envelope, and for a mode of effecting the circulation of the electrolyte. Nothing is stated as to the composition of the active materials with which the supports are respectively pasted. For aught we know to the contrary, the horrible old mixtures of red lead and litharge with dilute sulphuric acid may be employed for the pasting. In this case, even the celluloid envelope would not ensure permanent conductive contact between the active materials and the metallic supports, and mere juxtaposition is by no means sufficient.

The specific capacity virtually claimed for this accumulator is—

$$\frac{\text{Ampere-hours}}{\text{lb. gross weight}} = 6{\cdot}54,$$

according to one set of experimental data supplied. According to another set of data, the value calculated is 5·8. In either case, the value is extremely high, and, of course, requires further confirmation. The maximum specific rate of discharge we are allowed to derive from other data furnished is:

$$\frac{\text{Amperes}}{\text{lb. gross weight}} = 1{\cdot}9;$$

but there is sufficient evidence that this cannot be taken as a practical value.

It may, I think, be allowed that, under certain realisable conditions, the plates, enclosed as they are in an envelope of celluloid, would stand a great amount of rough treatment. It will be interesting to follow the further evolution of this cell, which is obviously at present in a somewhat primitive stage.

Desmond G. FitzGerald.

"Transmission of Power to Long Distances, &c."

Mr. Esson's paper is undoubtedly a good summary of the developments that have taken place in electrical transmission during recent years, and as such does not, of course, lend itself much to discussion. He, however, raised several points which seem to be opposed to the practice of the largest firms engaged in installing these plants, and it is to be regretted that a more thorough discussion did not take place when the paper was read.

Mr. Esson did not attempt to deal with transmissions requiring less than 1,000 volts; and it is a pity—since papers on this subject are so rarely read—that he did not consider

more the use of alternating currents for power transmissions over short distances for purposes such as electrical power is usually used in this country, as by so doing he would have appealed to a larger audience.

The apathy of English engineers towards the subject is, no doubt, due to the fact that there are such few opportunities for long distance transmission in this country, and they do not care to risk its use in other cases, owing to want of experience of its working.

It is to be hoped, however, that some share of the orders which are bound to come from our own and other colonies for plants on this system will fall to our share, and that this branch of the trade will not be left entirely to foreign firms.

The question then arises as to whether Mr. Esson considers that short distance power transmission will be dealt with solely by the direct system; and if so, is he correct in his views?

That such will be the case is decidedly open to question, and to anyone who had had to deal with both systems in operation, the thought must have occurred that the tendency will be in the other direction.

That a multiphase transmission is more complicated, as a system, than the direct is undeniable; but are such practical complications as having three wires instead of two, and a three instead of a two-pole switch and fuse, of much weight in determining which shall be adopted? The governing factor will rather be the generator and motors, especially the latter. The advantages and drawbacks of continuous current machines are well understood, and Mr. Esson has stated the case from his point of view for alternating ones, and it would only remain in any given case to sum them for either system. The general idea amongst engineers seems to be that for an installation where small motors will be chiefly used, such as to drive individual machines, continuous current is the correct thing; but if the same gentlemen had some experience with small induction motors, with their short-circuited rotors, and started on full load, even up to 9 H.P., by merely throwing the switch in, and capable of being reversed in an extremely short time, it is hardly doubtful that their opinions would change. But the comparison between these, like all other puddings, must be made in the usual way.

Mr. Esson is not quite clear when dealing with the copper economy and voltage questions. For any given case the minimum weight of copper required will depend upon what conditions limit the pressure, and only on that basis can a correct comparison be made. He assumes the pressure limit to be imposed by the pressure between any two wires; but it is not a just basis, except in the case of a concentric cable, as it is evidently immaterial as far as safety to limb is concerned whether the pressure between two wires is 7,000 or 10,000 volts. The points which decide pressure limits are:—

1. A safe insulation from a ground, as settled by the insulators.

2. The pressure that can be safely used in the generators or transformers.

When judged from these standpoints, the three-phase has a decided advantage in copper economy over either the single or two-phase, since it will be found that the pressure limits are not imposed by that between two wires, but by the voltage between any wire and the neutral point or earth. Consider, for example, a single-phase generator of 1,000 volts, with insulators and line to suit. Replace the single winding by three distinct circuits on the three-phase plan, each circuit having the same number of turns—*i.e.*, generating 1,000 volts—as the single winding had, and the insulation and general construction remaining the same. The probability of a breakdown between any winding and the iron of the generator, or of the failure of an insulator on the line is no greater than it was before in the single-phase system, and if the three sets of windings can be insulated from each other, where they cross, so as to allow for the relatively higher pressure between them—a condition easily satisfied—there will be no more risk in using the latter than the former system. Moreover, the same argument holds with regard to the transformers, the three separate windings being on three separate limbs. But the copper necessary for equal losses in transmission will now be in the ratio of $1 : \frac{1}{4}$, instead of $1 : \frac{2}{4}$, as stated by Mr. Esson.

It is certainly a surprise that Mr. Esson should speak so strongly in favour of the two in preference to the three-phase system, as it does not agree with the general tendency of American and Continental practice. His chief point seems to consist in the evils of unequally loaded circuits, but seeing that he treated solely of power transmission the argument does not hold; and even if there were a considerable lamp load on it is a very easy matter to divide it up between the three wires. Why, however, should not the same objection hold for the two-phase, as the tendency would be to cause a difference of pressure in the two circuits? There is a symmetry about the three-phase system, with its three *equal* wires, which simplifies matters, but on the whole, with the exception of the copper question there is perhaps not much to choose between them.

You have already corrected Mr. Esson with regard to the generators, so nothing need be said further. One feels doubtful whether Mr. A. Siemens were really serious in his remarks, or as to whether they were not rather thrown out to show those present what a field of argument there was open for them, since one can hardly see any comparison in the two systems in flexibility and economy in long distance, high voltage, large power transmissions, although naturally in a few special cases the use of direct currents might be preferable.

Percy Nicholls.

Manchester,
April 12th, 1897.

Resistance Material.

I write to ask if any of the readers of the Electrical Review know of a resistance material having a low temperature coefficient like platinoid, manganin, &c., but being at the same time comparable with iron in price.

Many expensive alloys have been produced having a good temperature coefficient and a high specific resistance. The latter quality is in many cases immaterial, though the constancy of the resistance of a wire at all temperatures is very desirable, and in some instances essential.

If a cheap material having a low temperature coefficient, but not necessarily a high specific resistance, is procurable, I shall be very glad to hear of it.

H. D.

Trunk Telephones.

La deuxième explication de M. Gavey, comme la première, ne m'explique rien du tout, et les arguments qu'il fait valoir paraissent démontrer tout juste le contraire de ce qu'il vent prouver.

M. Gavey cite un exemple dont il tire cette conclusion : le téléphone demeure silencieux quand le courant agissant sur lui est gradué ; il se trouve au contraire actionné du moment où ce courant n'est plus gradué. C'est prendre beaucoup de peine pour en arriver à confirmer tout simplement ce que je ne cesse de lui exposer.

De quelle manière Van Rysselberghe est-il parvenu à étouffer le bruit des signaux télégraphiques dans le téléphone ? En ayant recours á des appareils développant de la self-induction, et par le fait, capables de graduer l'émission du courant, tant au commencement qu'á la fin, et de l'empêcher de s'établir brusquement à son intensité entiére, comme aussi de tomber d'un coup de cette intensité à zèro ; ou, pour adopter la manière de parler de M. Gavey, en faisant appel à la self-induction dans le but d'obtenir un aplanissement de la courbe du courant. Tout arrangement venant contrecarrer l'action de la self-induction doit avoir pour effet d'enlever au système son efficacité et de rendre aussitôt les signaux télégraphiques audibles dans le téléphone. Or, quelle est l'action du condensateur shunté ? M. Gavey nous l'apprend : "the introduction of shunted condensers hastens the rise and fall of the current curve." Le condensateur shunté fait exactement l'opposé de la self-induction, il doit, par conséquent, détruire l'action de celle-ci et son introduction dans un circuit télégraphe-téléphonique d'aprés Van Rysselberghe, avec les valeurs que j'ai données dans ma dernière lettre, devrait avoir pour résultat de rompre le silence dans le téléphone. Pourquoi n'en est-il pas ainsi ? Voilà à quoi il s'agit de repondre.

Pour terminer, je me permettrai de faire remarquer à M. Gavey que la derniére partie de sa lettre semble faire voir qu'il connaît bien mal le système Van Rysselberghe, et je lui

serais vraiment obligé si, avant d'essayer une troisième explication du phénomène que nous occupe, il voulait bien examiner d'un peu plus prés la maniére d'agir de ce système.

J. Pierart.

Bruxelles, *Avril 15th.*

Function of the Element in Cable Speeds.

Owing, doubtless, to my having omitted to number the two diagrams in "The Function of the Element in Cable Speeds," published in the ELECTRICAL REVIEW, of April 16th last, your printer thought well to insert these diagrams in the reverse order to that in which they appear in my manuscript. This circumstance has constituted a puzzle in some quarters, but the article in question has met with such appreciation from those well qualified to judge, that I beg leave to write this word of explanation.

E. Raymond-Barker.

April 21st, 1897.

[We fail to see how anybody could be puzzled, as both diagrams are specifically referred to in the text. The order in which they appear ought to make no difference to readers. —EDS. ELEC. REV.]

OZONE AND ITS COMMERCIAL PRODUCTION AND APPLICATION.

A SHORT time ago we visited the laboratory of Mr. E. Andreoli, and were extremely interested to see the ingenious apparatus by means of which he has succeeded in producing ozone in the diluted form on what may reasonably be termed a large scale. We are rather glad, however, that we decided that before noticing the advances which Mr. Andreoli has made in this interesting department of research, to wait for the appearance of a paper which he then had under preparation for the Society of Chemical Industry. In this paper the author has gathered together more information on the subject of ozone than was available in any other source. It only requires a short appendix of the bibliography of the subject in order to render it still more complete and valuable.

The most formidable obstacle to be surmounted in producing large quantities of ozone is the heat of the discharges which destroy it. When the temperature rises, the glass which separates the metallic electrodes loses its dielectric properties, and gradually becomes a conductor. After a while the current begins to pass through the glass; the latter cracks, and the apparatus ceases to work. Owing to heat, the continuous generation of ozone has, up to the present, been impossible. The electric silent discharge, notwithstanding its inoffensive appearance, causes a considerable rise of temperature, and it is easily conceivable that its luminous waves being continually emitted from the electrodes on to a glass surface, will eventually yield disastrous results and reduce the yield of ozone to a minimum. To get over this difficulty the air to be ozonised must be left as little as possible in contact with the electrical surfaces or with the points of the electrodes. The larger the electrodes the less satisfactory the ozonisation will be, because the longer the passage between the electrodes coated, so to speak, with a layer of flame, the higher will be the temperature of the gas. This means that to work under the most advantageous circumstances the distance to be traversed by the gas to be electrified must be extremely small. If this condition is not realised, and the ozonised gas is not very rapidly drawn from the electrifying surfaces, no quantity of ozone greater than 12 to 15 grammes per electric horse-power-hour will be available. If the air is driven through the ozoniser at a convenient velocity between the ozonising surfaces, and its contact with these surfaces is extremely short, a comparatively large amount of ozone will be obtained, even after abstracting from it the nitrous compounds which increase as the contact of the air with the electrodes is prolonged.

Mr. Andreoli has been the first to construct an ozoniser which does not present this disadvantage. He calls his apparatus the open ozoniser, and its principle is to use two dielectrics, between which and apart from them is a metallic plate. The metallic plate bears a very large number of points, and between the opposed rows of plants the discharge takes place, and air being forced through the apparatus, leaves it in an ozonised condition. In some analyses made by Prof. Ramsay, as much as 34·5 grammes of ozone per horse-power-hour was found. Now Mr. Andreoli has succeeded in obtaining 48 grammes of ozone per horse-power-hour; but assuming that the yield is only 30 grammes, the cost at 1d. per horse-power-hour would be:

	£	s.	d.
300 grammes for 10 horse-power-hours	0	0	10
3 kilogrammes for 100 horse-power-hours... ...	0	8	4
30 kilogrammes for 1,000 horse-power-hours ...	4	3	6

This result is of itself worth the amount of patience and trouble which Mr. Andreoli has given to it, for we now know what it costs in practice to produce ozone for use for industrial purposes. A short description of the type of apparatus most commonly employed by Mr. Andreoli may not be out of place:—The main object has been to have a large electrifying surface, and at the same time to prevent the rise of temperature caused by the electric effluvia. The electrodes are boxes through which cold air or a cooling liquid may circulate. One set of electrodes is connected to one pole of a high tension transformer, the other is connected to the other pole, and there is between each electrode a glass separator or dielectric. The electrodes are narrow and long; they are kept at a proper temperature by cold air or water; they work on both sides, and their point-bearing surface is very large and active. But it is not sufficient to have some means for cooling them; the longer the air is in contact with the electrodes and with the dielectric the warmer it is, and therefore the smaller the quantity of ozone formed. To obviate this, the air is forced from beneath between the electrodes, through the slits or apertures of a false bottom. Its velocity is high; the gas traverses a very short electrifying space, and almost as soon as the gas is ozonised it is removed from contact with the glow of the silent discharge.

Although the oxidation of metallic electrodes is not so dangerous as some people say, and the loss of ozone in this respect is therefore slight, an attempt was made to remove, or at least diminish considerably, the possibility of this occurrence. This was attained by covering the electrodes, that is to say, the point-bearing metal boxes, with a few coatings of a varnish, which resists a much higher temperature than that which might rise in ordinary ozonisers, and which is practically inoxidisable.

Flat electrodes may be employed, but electrodes provided with numerous points are preferable, which on both sides of a dielectric separator are set to work points against points, or points against flat surfaces. There is more to be said than one would think about the influence and *rôle* of points in the production of ozone. It is obvious that the electric effluvia will flow out better and more powerfully from a flat plate, on which the tension is uniform. More ozone is formed on angles or points than in condensers with flat surfaces or in plain tubes, &c. It is at the top of a cone that electric density has its greatest value; and electricity accumulates there so abundantly when the point is very sharp, that in spite of its insulating properties, the ambient air is electrified, repelled, and replaced by a fresh amount of air, which is in its turn electrified, and so on. Points have not, as Franklin thought, power to attract the electric fluid, but they have the property of liberating and discharging with the greatest rapidity the electricity with which they are charged. Each square foot of Andreoli's electrodes bears 46 rows of 56 double points, and in the ozonisers of 12 boxes the number of points is 53,760.

Turning now to the paper read before the Society of Chemical Industry, we find that it mostly consists of extremely suggestive matter, although it is somewhat speculative. We think Mr. Andreoli is quite justified in his speculations, since some time ago Dr. Frolich, a learned German electrician, was able to foresee a future for ozone, and believed in its commercial application when the yield which manufacturers were able to obtain was very much lower. Ozone will do what oxygen cannot do, and this of itself constitutes a look out for this substance. Amongst the applications to which ozone may be put, or has been put, we may mention the following: Mr. Andreoli has constructed numerous small apparatus for household purposes; these can

be operated intermittently or continuously, and will disseminate ozone throughout the atmosphere of the house. It is conceivable that apparatus of this kind would be particularly useful in halls, theatres, and other places where many people are congregated together, and where the atmosphere usually becomes more or less injurious, owing to the difficulty, probably, of procuring sufficient ventilation.

Ozone has been prescribed by physicians both in England and abroad in the treatment of ulcerous wounds, and the cure of consumption and other diseases.

Mr. Andreoli also referred to the employment of ozone in the manufacture of aerated waters; in the purification of beer casks, the destruction of the ferments which cause diseases of beer; in the manufacture of "degras" for the leather industries; in the preparation of wood for making musical instruments, cabinet and carriage work; in the bleaching of linen cloth and yarns; in the bleaching of starch and other amylaceous products; in the vinegar industry; in the decoloration of molasses, syrups and moist sugar; in the preparation of drying oils and the manufacture of linoleum; in the preparation of a disinfectant by ozonising turpentine; in the sterilisation of water; in the operations of bleaching in conjunction with other agents; in the maturing of spirits and wines, &c.

The paper evidently excited a great deal of interest, for the discussion was unusually long, and although some of those who spoke seemed to think that the paper was a little too speculative, all agreed that it was the best contribution on the subject which scientific literature has yet seen. This is in the nature of a new subject; Mr. Andreoli has certainly carried our knowledge of ozone further than anyone else has yet done, and it is sincerely to be hoped that manufacturers will be induced to take advantage of his invention to try commercial experiments free of cost, the plant and everything necessary being supplied.

PROF. VIVIAN B. LEWES ON ACETYLENE.

In one of his recent Cantor lectures on the use of gas for domestic lighting, Prof. Lewes had a good deal to say respecting acetylene. He considers that at the present moment its future as an illuminant is largely dependent upon two factors, namely, the commercial production of calcic carbide of a reasonable degree of purity; and, secondly, methods for safely making and burning the gas in such a way as to develop its full illuminating power, whilst doing away with the risk of smoking.

In spite of extended experience, both here and abroad, in the manufacture of calcic carbide, the details given as to its cost and the price at which it can be purchased offer the most entertaining reading, as whilst the patentee and would-be seller of acetylene generating plant still talks airily of the cost of the carbide being anything from 30s. to £7 a ton, the price at which one can purchase carbide more nearly approaches £30. Indeed, in Paris, at the present moment, there is considerable difficulty in getting it at £40 a ton, although we are informed that this is merely due to a temporary carbide famine, and that the new sources of supply will soon reduce the selling price even below £16 a ton, at which it stood before the late rise in price. Be this as it may, the factor which interests us is the price at which carbide can be obtained in England, and the Acetylene Illuminating Company, who hold the Wilson patents for the production of carbide, and also the Cowles electric furnace patents, which enable them to control the manufacture of carbide in this country, have fixed their selling price at £28 per ton, and although there is no doubt that they will give contracts in considerable quantities at a reduction on this price, yet it is with the factor of the selling price to the public, and not with the manufacturing price that we have to deal.

In most cases, the possible prices quoted for calcic carbide by inventors who have been carried away by their wishes rather than by hard facts, are simply absurd, and far below the price at which the substance can be produced, and it may be of interest to give the figures for the electric power necessary, which Prof. Lewes has obtained in practice in the manufacture of calcic carbide.

The experiments were conducted at the works of the Acetylene Illuminating Company with a plant capable of working continuously at from 60 to 70 volts and 1,000 to 1,200 amperes.

He found that using a mixture of 60 per cent. of lime and 40 of carbon, a run lasting 3½ hours yields about 112 lbs. of fused ingot, and of this 81 per cent. was practically pure carbide, the remainder being a crust of lower value.

The mixed carbides yielded 5 cubic feet of gas per pound, and contained 89·2 per cent. of true carbide, hence the yield may be taken as being 32 lbs. per hour of the commercial carbide.

The current used was 1,000 amperes at 60 volts, or 89 E.H.F., which gives as the make about 0·4 lb. per E.H.P. per hour, and the results of continued experiments show that 0·3 to 0·4 lb. per E.H.P. per hour is the average yield.

The cost of the electrical horse-power will, of course, vary with the source from which it is obtained, and the use of steam power for generating the electricity appears too costly to be entertained, unless the present electrical lighting stations could see that it was to their advantage to level up their load by manufacturing the carbide under license when not employed in supplying current directly for illuminating purposes.

Pro. Lewes considers that the gas obtained from the English carbide is very pure, the chief impurity being 2-3 per cent. of sulphuretted hydrogen; many of the Continental samples, however, contained 6-9 per cent. of impurities, one of the principal and most dangerous being phosphuretted hydrogen, due to the use of phosphatic lime. Prof. Lewes thinks that no lime or coke should be used in the manufacture of carbide which contains more than the smallest trace of phosphates, and if this point is not more carefully attended to than it is at present in some of the Continental works, serious accidents are sure to follow, whilst if this be done, as is the case in the manufacture of English carbide, no danger from this cause need be apprehended.

Ammonia is also found as a frequent impurity in acetylene, and gives it the power of attacking copper with the formation of an explosive compound.

In the generation of acetylene from calcic carbide, far too little attention is being paid to the high temperature evolved when any considerable quantity of it is brought into contact with water, and to the effect which this has upon the gas.

In any form of generator where the quantity of carbide is large, the heat generated by the action of the water on the material is quite sufficient to polymerise some of the acetylene into tar-like products, which will sometimes cause trouble and stoppages in the pipes, whilst in any case the high temperatures cause a large amount of steam to go forward with the gas, and unless special precautions are adopted to prevent it, such as using a sufficiently large holder, some of this is carried forward to the service pipes.

The dangers of acetylene, of which a good deal has been heard lately, are almost entirely dependent upon the use of impure carbide and improper apparatus. Pure acetylene has now been shown to be less poisonous than ordinary coal gas enriched with carburetted water gas, whilst the action of the pure dry gas on metals is practically *nil*.

Acetylene gas when burnt gives a flame of intense brilliancy, and owing to its richness, it can only be consumed in small burners. Under these conditions it emits a light greater than that given by any other known gas, its illuminating value when properly developed, calculated to a consumption of 5 cubic feet an hour—the average consumption of ordinary coal gas—being no less than 240 candles. It is thus seen that when acetylene is burnt in suitable burners it develops an illuminating value 15 to 20 times greater than that obtained by the combustion of the same volume of coal gas, so that for all practical illuminating purposes a very small consumption of acetylene in the burners, which practice has shown to be best suited for the purpose, does the illuminating work of a very large volume of coal gas, with the result that the air of the room is but little contaminated with the products of combustion, and the excessive heating of the upper portions of the air is reduced to a minimum.

There are many places in this country where the cost of good gas coal makes coal gas prohibitive in price, whilst on the Continent these troubles exist to a far greater extent, and if it were commercially possible to use acetylene as an enricher of a cheap fuel gas an enormous field would be opened up.

When acetylene was first rendered a commercial possibility, numbers of experiments were made in order to see if this could not be done, but the results were most discouraging, as instead of each 1 per cent. of acetylene added to the diluting gas giving a value of about 2 candles, it was found that it was necessary to add something like 10 to 15 per cent. before the mixture became endowed with any luminosity at all, and that with water gas, an admixture with 20 cent. of acetylene was necessary to give anything approaching a 20-candle gas. With a poor coal gas, however, the enrichment value of the acetylene gives better results, but still not sufficiently good to hold out any great hopes of acetylene replacing oil as a means of enrichment.

The result is, that it would be perfectly easy by a simple and rapid process to make a fuel gas costing from 8d. to 1s. per 1,000, and by the addition of 10 per cent. of acetylene to raise this to an illuminating value of about 20 candles, a result which, given a cheap carbide, would open up an enormous use for acetylene gas.

In the last sentence we have a key note to the situation, "given cheap carbide," and "acetylene gas shall have an enormous future." That is the problem to be tackled. When acetylene was first boomed, the gas companies grasped at the idea of utilising it as a means of bringing their own product up to a reasonable illuminating power, but it seems that this hope must be abandoned, and gas companies must recognise in acetylene not a helpmate, but a competitor. It seems far more likely to provide electricians with work to do than gas engineers. At present the cost is still prohibitive, and there are difficulties and dangers connected with its use. Whether this will be overcome or not remains to be proved. The Acetylene Illuminating Company has a good chance, inasmuch as it has procured cheap power at Foyers. If it fails, we shall have to place acetylene on the shelf, and in future speak of it tenderly as of a child of many prayers who disappointed its too sanguine parents and proved a failure.

THE EXTRACTION OF METALS FROM THEIR ORES BY MEANS OF ELECTROLYSIS.

All those who are in any way interested in the treatment of ores by electrolysis, with a view to obtaining the metals from them, should not fail to notice the analytical reports made by C. Schnabel in the *Chemiker Zeitung*. Schnabel is a recognised authority on these matters, and every year he sums up the progress which has been made in not only the electrolytic treatment of ores, but also what progress has been made in other methods of treatment. For us, however, the interest rests with the electrolytic processes, and consequently we give below some extracts from a report by Schnabel in the *Chemiker Zeitung* (*vide* 1896, Vol. xx., pages 595 to 599). This particular report refers to the non-ferrous metals, and deals with zinc, gold, silver, nickel, copper and aluminium.

Zinc.—In treating zinc ores electrolytically, the main endeavour has been to obtain solid metal, free from slime. So far, however, the process has not been successfully applied to the extraction of zinc from rich ores, although it is used to recover the metal as a by-product from pyrites and argentiferous galena or blende. For the treatment of burnt pyrites, the processes of Höpfner (who converts the zinc in them, and electrolyses the chloride) and V. Kittler are used. For the other ores named, the methods of Ashcroft, Höpfner, Siemens and Halske, and Pape are available; the two former use chloride solutions, the two latter sulphates. The Ashcroft process is in use at Newcastle (N.S.W.) in connection with Broken Hill ore. The ore is roasted and leached with ferric chloride, which gives zinc chloride and ferric hydroxide; on electrolysis of this a compact zinc is deposited, and the solution is regenerated. The residue, containing less than one-third of the original zinc, is smelted for argentiferous lead in blast furnaces, the ferric oxide assisting as a flux for silica. In electrolysing, iron anodes are first used, so that ferrous chloride may be formed, and then carbon anodes are substituted, in order that the liberated chlorine may peroxidise the iron salt. Between the electrodes there is a canvas partition to prevent the access of iron solution to the cathode, and the zinc liquors are circulated first through the cathode department, and then, when nearly freed from zinc, through the iron and carbon anode compartments successively, they are finally returned to the ore-leaching vats. By maintaining a rapid circulation and higher level of liquid in the cathode chamber than in that containing the anodes, the ferrous liquor is excluded from the former, and the zinc is therefore practically free from co-deposited iron. The metal is remelted. The electrodes in each bath are placed parallel, but the baths themselves are coupled up in series. The current strength used is 50—60 amperes per sq. m. at 1·1 volt pressure in the baths with iron anodes, and 2·7 volts in the others, and the expenditure of coal under the boilers is equal to from three to four parts by weight for one part of zinc recovered. The chief cost in this process is in the consumption of anode iron, which amounts to 67 parts by weight per 100 parts of zinc. The electrolytic refining of zinc containing lead is practised at Ilsenburg, but the extraction of zinc from alloys of zinc, lead and silver at Hoboken (Antwerp) is diminishing in favour, the distillation of the zinc from the alloy, followed by the separation of the silver and lead, having been found more advantageous. The market for zinc salts is very limited, but the sulphate is made at Juliushutte and Sophienhutte (Goslar), by leaching roasted mixtures of galena, blende, and pyrites in rotating iron drums. The conversion of zinc sulphate into oxide has not yet been economically effected.

Gold.—The Siemens-Halske electrolytic process for the recovery of gold from cyanide liquors is in use by the Rand Central Ore Reduction Company, at Johannesburg, and thereby 70 per cent. of the precious metal in the ore is recovered. The electrolytic separation of gold and silver has been successfully practised at Pittsburgh and St. Louis, U.S.A., and at Pinos Altos, in Mexico, and more recently at the Deutsch. Gold-u. Silb., Scheideanstalt, Frankfort-on-Maine.

Silver.—The Rossler-Edelmann process for the desilvering of lead by zinc containing aluminium, followed by electrolysis of the resulting zinc-lead-silver alloy has been given up in Lautental in favour of the old process, and is but little employed in Hoboken. The zinc skimmings of the Parkes process are now distilled in the United States in petroleum-fired retorts. The treatment of argentiferous and auriferous anode slimes, consists usually in obtaining the precious metals in alloy with lead. Where this cannot be done, the slimes are treated in the wet way, and are either (1) stirred with silver sulphate solution, which causes the copper to dissolve and precipitate an equivalent of silver; or (2) they are digested with dilute sulphuric acid in the presence of air, to oxidise and dissolve copper; or (3) they are boiled with strong sulphuric acid, which dissolves both silver and copper, and leaves the gold untouched; or (4) the slimes are cast into anode plates and treated by electrolysis.

Nickel.—Basse and Selve (*Chem. Zeit.*, 1892, 16, 1725) patented a process for electrolysing nickel salts, consisting in adding organic compounds (tartaric or citrate acids, glycerine, or dextrose) to maintain the oxides in solution, and then an excess of caustic alkali, electrolysing the bath with a current of 0·3—1·0 ampere per sq. dm. In this way iron, cobalt, and zinc, were deposited at the cathode, whilst the nickel remained dissolved, or partly precipitated as hydroxide, according to the concentration of the bath. Ammonium carbonate was afterwards added to the bath, in quantity sufficient to carbonate the whole of the caustic alkali, and the nickel was then obtained on the cathode by electrolysis.

Copper.—The electrolytic refining of copper is now greatly facilitated by the use of compressed air, according to the systems of C. and H. Borchers, and Siemens & Halske. The air is introduced under pressure through lead pipes, terminating in glass jets near the bottom of the vats; by this means arsenic and iron are both precipitated (as arseniate of iron), the liquid is circulated, and the current density may be safely increased from 30 — 50 to 100 amperes per sq. m. When the electrolyte is saturated with bismuth and antimony, taken up from the anode, it must be removed, and treated with copper oxide or basic copper salts in a separate vessel, a current of air being meanwhile passed through the liquid. After filtration and acidification the liquid is used again. The Hayden process has not been extended in the United States, and the process of Smith and Randolph has

but a limited application. In all three processes the raw copper plates must necessarily be of equal thickness, which necessitates costly preparation by rolling and cutting to size; but even then there are irregularities in the plates for which allowances cannot be made. The advantage of the processes consists in the rapidity of the solution and the moderate thickness of the plates, entailing only a comparatively small locking-up of capital. In Baltimore, Hayden's process is in use, and by it plates 6·44 mm. thick are treated in 12 days with a current of 160 amperes per sq. m. The three processes have not been used in Europe.

Aluminium.—Bucherer, of Cleveland (*Chemiker Zeitung*, 1892, xvi., p. 1764), and the Aluminium Industrie Gesellschaft Neuhausen (*Chemiker Zeitung*, 1893, xvii., p. 1006), electrolyse aluminium sulphide, either (in the latter process) alone or in a bath of alkaline, or alkaline earth chlorides or fluorides, the electrolyte being heated either by the current or by external firing. For an externally fired bath of the sulphide in sodium or potassium chloride, a current pressure of 2½ to 3 volts suffices, whilst for the electric heating of the mixture by the electrolysing current, 5 volts are required. The bath is of cast or of wrought-iron lined with carbon, and the upper part of the vessel is filled with reducing gases. Owing to the comparatively low temperature which suffices for the purpose, neither the carbon anode nor the lining is attacked by the sulphur set free, and the aluminium produced is exceptionally pure. The chief obstacle so far to the use of the process is the high cost of the aluminium sulphide.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending April 20th, 1896	£	s.
Adelaide	27	0
Amsterdam	25	0
Bombay	40	0
Buenos Ayres	12	0
" " Teleg. mat.	51	0
Cape Town	449	0
" " Teleg. mat.	15	0
Calcutta	33	0
Colombo	86	0
Copenhagen	13	0
Delagoa Bay	100	0
Demerara	18	0
Durban	6	0
East London	380	0
" " Elec. cable	522	0
" " Teleg. wire	207	0
" " Teleph. mat.	18	0
Malta. Teleg. cable ...	816	0
Melbourne	50	0
Piræus. Teleg. mat. ...	19	0
Port Elizabeth	28	0
Reval	65	0
Singapore	25	0
Stockholm.	251	0
Sydney	151	0
Wellington	244	0
Total	£3,651	0

Week Ending April 20th, 1897.	£	s.
Adelaide	68	0
" Teleg. mat. ...	36	0
Baltimore. Teleph. mat.	19	0
Beira	37	0
Bombay	12	0
" Teleg. mat. ...	16	0
Buenos Ayres	175	0
" " Teleg. mat.	97	0
Calcutta	324	0
Cape Town	288	0
East London	601	0
Gibralta	15	0
Hamburg	328	0
Melbourne. Teleg. mat.	25	0
Monte Video	114	0
Otago	215	0
Passages	280	0
Port Elizabeth	292	0
Rosario	628	0
St. Lucia. Teleg. mat.	100	0
Sanda Ran	36	0
Singapore	12	0
Trinidad. Teleg. mat...	13	0
Total	£3,731	0

Bankruptcy Proceedings.—A statement has been issued of the affairs of Christopher Yates Young, carrying on business in St. George's Square, Huddersfield, as an electrical engineer, under the style of Young & Co. The liabilities are £109 11s. 5d., and the deficiency £100 6s. 4d. The debtor attributes his failure to bad trade and other causes.

"Canadian Manufacturer."—Our enterprising contemporary, the *Canadian Manufacturer*, intends publishing a special edition, containing, as soon as they become law, the new Canadian tariff, and the new United States tariff, and also the British tariff and the British Merchandise Act. The importance to manufacturing, industrial and commercial communities of the three countries named in having these important papers accurately reproduced, within one edition, is obvious.

Change of Name.—Messrs. Frederick Smith & Co., of Halifax, ask us to draw attention to the change which has been made in the name of the firm now that it has, for family reasons, been turned into a limited company. The name will be "Frederick Smith & Co., Wire Manufacturers, Limited."

Consular Reports.—Of recent years Consular Reports to the Home Government have bristled with valuable suggestions to manufacturers and exporters, and as an instance of this we commend the following extracts from a recent report to Lord Salisbury by Consul Wyndham on the trade of Barcelona for 1896:—"It may be pointed out that although there are many firms who are moving in the right direction in the way of catalogues, and some are very nearly perfect, yet much remains to be done by the majority of manufacturers. They ought to bear in mind that it is almost useless sending out catalogues in English. More care ought to be observed in the translations, which are often evidently confided to persons entirely ignorant of machinery, with the result that Anglo-Spanish catalogues are often as funny as Germano-English. It is absolutely necessary for the proper translation of machinery catalogues that the translator should understand not only the language but also the machinery. Again, some otherwise valuable catalogues are spoilt by the weights and dimensions being given in English instead of being reduced to the metric system, whilst production is stated per day or week without specifying the hours, and consumption of gas or petroleum motors is given in pence per 'horse-power,' instead of in cubic metres of gas or litres of petroleum. In many also, the vague statement is found, 'packing and delivery extra,' but no amount is given. As many makers may hesitate at the cost of translations into various foreign languages, it may be of use to them to know that French is usually understood fairly by the industrial population. A catalogue in that language, if properly translated and with the weights and measures according to the metric system, will be usually sufficient for Spain, especially this district. English firms show themselves chary as a rule of giving clear information about any improvement or special notion they offer. They extol the merits of the same, but do not condescend to give any practical explanation, whereas a diagram or drawing would, as a rule, be worth pages of testimonials which no one reads, to convince a buyer of its advantages. Finally, a mass of loose leaves of various sizes and colours, and page after page of testimonials, usually find their way straight into the waste paper basket. The catalogue which stands the best chance of being kept and consulted is the small or medium sized pamphlet or book, in which prices, packing and delivery charges, f.o.b. to English port, gross and net weights and cubic measurements, are all clearly stated. Copies of testimonials are useless, a well digested list of users being of more value to convince the purchaser. A very large number of firms have adopted the plan of writing to the Consul and asking for the names of dealers in their particular line of goods in this district, and have then communicated with the firms whose name the Consul has forwarded to them. Next to sending travellers to seek for custom, this appears to be the best method of bringing goods to the notice of buyers, and although it greatly increases the consular correspondence, such information is always readily given. It is estimated that the value of the cables and other plant introduced for the distribution of electricity in Barcelona amounts to about £400,000, whilst the total value imported through the port of Barcelona is stated to be about £830,000. There is also an Anglo-American company, so-called, but I believe really an American company, who are trying to obtain a grant of the right to run electric trams here, and I understand they have received support at Madrid. The Town Council, however, are considering the proposal. The mule tramway company of Barcelona, which is a British corporation, and who have lines laid down all over the city, are naturally fighting for their rights, which the electric tram company would certainly invade."

It appears from a report to the Foreign Office on the trade of Saigon, received from Consul Tremlett, that there has been a good deal done there in electric light machinery, and with the exception of the post office, all by foreign firms, English for the most part. The cities of Saigon and Cholon are to be lighted by electricity, but it is not certain whether the contract has been settled; the money, however, has been voted.

Dissolution of Partnership.—The partnership hitherto existing between Mr. H. D. Parmiter and Mr. F. M. H. Barber, A.I.E.E., was dissolved by mutual consent on April 7th. Mr. Parmiter retired on that date, and Mr. Barber informs us that he will now carry on the business as sole proprietor under the title of Donnison, Barber & Co., and attend to the debts of the late firm, Donnison, Parmiter & Barber.

Gas.—A purifier at the Manchester Corporation Gas Works, Rochdale Road, burst on Saturday last, injuring ten men, three rather severely.

At Cuthill Road, Camberwell, on 15th inst., there was a serious gas explosion caused in the usual manner.

Liquidation Notices.—Creditors of the Wigston Electrical and Engineering Company, Limited, are required to send their names and addresses and the usual particulars to the liquidator, Mr. A. B. Wykes, 24, Friar Lane, Leicester, by May 26th.

McCrudden v. The Mazarron Electric Light Company, Limited.—This was a claim, already reported in the Electrical Review, by Mr. Hugh McCrudden, electrical engineer, 64, Sayer Street, New Kent Road, to recover the sum of £16 13s. 4d. for a month's salary in lieu of notice, against the defendants, of Dashwood House, New Broad Street. When the case came on again at the Lord Mayor's Court on 13th inst., the jury found for the plaintiff for the amount claimed.

Steam Engines.—The Leeds Corporation, for the extension of the Meadow Lane Gas Works, have accepted the tender of Messrs. R. and J. Rankin, of Liverpool, for two horizontal engines required for the new retorts.

Westralian Exhibition.—The Agent-General for Western Australia has received a telegram from Coolgardie stating, for the information of manufacturers, that an "International Exhibition of Gold Mining Machinery, under Government auspices," opens at Coolgardie on October 1st next.

ELECTRIC LIGHTING NOTES.

Battersea.—At the last Vestry meeting cheques for £13,900 were drawn in favour of the vendors of the property in Lombard Road and Harroway Road required as a site for the electric light station. The Electric Lighting Committee announced that they had arranged for the lighting of the municipal buildings by electricity. An engineer (at £2 10s. per week) and a stoker (at 32s.) are to be advertised for. The offer was accepted of the National Boiler and General Insurance Company to insure the boilers in the electric lighting station for the sum of £2,000, at an annual premium of £6.

Beckenham.—The District Council have received a letter from Messrs. Muirhead & Co. asking if the Council are disposed to negotiate for the transfer to them of their electric lighting order. A committee is considering the matter.

Belfast.—The extension scheme came before a special meeting of the Corporation on 12th inst., and after a lengthy discussion was adopted. The total cost of plant, machinery and buildings is to be £65,000. The plans, specifications and estimates, prepared by Mr. M'Cowen, the city electrical engineer, were approved, and application will be made to the Local Government Board for sanctioning a loan. An amendment postponing decision until after the settlement of the arrangements pending between the Corporation and the tramway company regarding the working of the tramways by electricity.

Bolton.—At last week's meeting of the Gas and Electric Lighting Committee, it was reported that the receipts in the electricity department for the 12 months ended March amounted to £5,441 10s. 5d., or £1,317 11s. 10d. more than was received in the previous year. It is, perhaps, worthy of note that there was also an increase of £6,605 19s. 10d. in the gas takings upon the preceding 12 months.

Bradford.—The Town Council last week passed a resolution determining upon the extension of the area of electric lighting supply, so as to include the whole of the borough.

Brighton.—The manager of the electricity works has been instructed to purchase two bicycles for the use of the arc lamp inspector and the fuse attendant.

Bromley (Kent).—The District Council have resolved that they will, subject to certain conditions, transfer their powers under the Electric Lighting Order of 1891 to an improved local corporation, and the Bromley Electric Supply Corporation propose to take over the powers if terms can be arranged.

Canterbury.—The electric lighting question came before the Council last week, and as a result the scheme will go forward. It is proposed by the House Committee that the Board of Trade be petitioned to extend the time for carrying out the provisional order.

Cardiff.—The Corporation is to be approached by the Board of Guardians as to its terms for supplying current for lighting the Workhouse.

Mr. Harpur, the borough engineer, reports that the cost of lamps and erection of same, for lighting the back lanes of the town would be £430, and the annual cost of maintenance £608.

Chelsea.—At a meeting of this Vestry last week, a letter was read from Mr. H. Cholmondeley-Pennell, calling attention to the annoyance caused to his tenants in Rossetti Mansions by the condensation of steam given off from the works of the adjacent electric light company, which, he was assured, frequently fell in the form of distinct, and sometimes heavy, rain, and asking the Vestry to take steps for the abatement of the nuisance. The letter was referred to committee for consideration.

Cheltenham.—Last week, the Lighting Committee recommended for adoption a schedule of electric lighting extensions, at an estimated cost of £3,515, and the Council resolved to apply for sanction to a loan for the purpose. Alderman Norman mentioned that in December last there were the equivalent to 7,500 lamps wired in the town, and now there were 9,650. In December the number of customers for the electric light was 127, and the number now was 144. The receipts for the year ended March 25th would be found to be a little more than sufficient to cover the working expenses, and he had every reason to believe that during the current year the receipts would also cover interest on capital.

Cork.—The new music hall in King Street is electrically lighted by means of a number of six and three light electroliers and single light brackets. The generating plant is situated in the basement, and comprises two 16-N.H.P. gas engines made by the National Gas Engine Company, two Taunton dynamos, a motor transformer, accumulators, &c. Messrs. Handley & Shanks carried out the works.

Electric Light in Salt Mines.—The company working the salt mines at Preesall, near Fleetwood, have completed an installation of the electric light which is much appreciated by the men employed. Previously, the work was carried on by aid of candlelight.

Glasgow.—The Electric Lighting Committee of the Town Council, in their desire to provide an abundance of the electric light current for all who wish it outside of the present compulsory area, have erected two sub-battery stations. One of them, says the *Glasgow Bailie*, is in the Tontine Lane and the other in Claremont Street. The Committee have agreed to accept the offer of Mr. A. B. Pescatore to provide and erect a battery at the former station for the sum of £3,460, and the one at Claremont Street (West-End) for the sum of £3,020. Thereafter he is to maintain both stations in a working condition for a period of four years at the respective costs of £185 and £160 per annum.

The new Electric Lighting Committee will consist of Bailies Cleland and Fife, River Bailie Anderson, and Councillors Finlay, Graham, Guthrie, Kerr, Maclay, R. M. Mitchell, Paton, Paterson, Primrose, Sorley, D. M. Stevenson, P. G. Stewart, Wallace, and James Willock.

Hammersmith.—The Vestry has referred the tenders for the supply of about 1,000 tons of the best Welsh smokeless steam coal for the electric lighting works to the Electric Lighting Committee.

Harrogate.—The Corporation electric lighting undertaking was inaugurated in the presence of a company of residents and visitors headed by the Mayor, Councillor Wilson. The "switching on" ceremony was followed by the usual banquet.

India.—The Bengal Government has sanctioned the expenditure of Rs. 80,000 for a complete installation for electric lighting at the Civil Engineering College at Seebpore.

Liverpool.—The Lighting Committee last week resolved to extend the electric main to Clarence Street, Oldhall Street, Brook Street, and Prince's Road. An extension in the Park Lane district has been authorised at an expenditure of £1,145.

Margate.—Messrs. Edmundson & Co. have offered to enter into an agreement with the Margate Town Council to take the proposed electric lighting in hand. Messrs. Edmundson will bear the cost of obtaining and transferring the order; will supply electric current for public lighting on reduced terms; will allow the Corporation to retain the right to purchase the undertaking upon terms to be agreed upon at any time; and will work the undertaking with a small local company. The offer has been referred to the General Purposes Committee of the Corporation for consideration and report.

Montrose.—Negotiations are in progress between Messrs. Edmundsons, Limited, and the Council for the supply of electric lighting to the town by the firm mentioned.

Newport.—The Council has re-appointed Mr. R. Hammond, consulting engineer, in connection with the proposed extensions. Application is to be made to the Local Government Board for sanction to a £30,000 loan.

Oldham.—At the meeting of the Electric Lighting Committee, it was stated that the approximate profits of the electric light undertaking during the year would be £1,080, and this would have been increased by upwards of £400 but for two unforeseen circumstances, viz., the repairs necessary at the reservoir at Rhodes Bank, and the alteration of lamps in consequence of the change from the two-wire to the three-wire system.

Plymouth.—Messrs. Lord & Shand, of Plymouth, have obtained the order for putting down an 80 (16-C.P.) light plant in the new works of the Devon and Cornwall Ice and Cold Storage Company at this town, the wiring to be done on the British Insulated Wire Company's system of twin conductors.

Preston.—On 13th inst. an explosion occurred in an electric light main culvert in Church Street, Preston. A manhole cover was blown to a considerable height. Happily the occurrence was unattended by any bodily injury.

Provisional Orders.—The Board of Trade have decided to grant provisional orders to the Reigate Corporation and the Urban District Council of Dorking, empowering them to supply electricity within the area of their respective jurisdiction. For this purpose Reigate Corporation are empowered to spend £15,000 and Dorking District Council £10,000. The Board have also granted an electric lighting order to the Barking Town Urban District Council, who are authorised to expend £15,000. The orders will require confirmation by Parliament.

Radcliffe.—We hear that the Council has adopted a report of the Electric Lighting Committee giving information as to probable cost and annual working expenses of an electric light installation, with steam and gas power respectively.

Rhondda (South Wales).—According to *Daily Tenders* the District Council informed the deputation who waited on them with regard to lighting the town by electricity by the company recently formed for the purpose, that they will not decide anything before the whole scheme is put before the Council.

Sheffield.—The Town Council on 14th inst. adopted the recommendation of the Parliamentary Committee, which advised the purchase of the undertaking of the Sheffield Electric Light and Power Company, Limited. A second resolution was passed agreeing to give the company notice requiring them to sell their undertaking.

Southampton.—In the House of Commons on 12th inst., the Bill confirming a provisional order of the Board of Trade for the electric lighting of Southampton was read a second time, and referred to a Select Committee.

The foundation stone of the new electric lighting buildings is to be laid on June 1st by the Mayor. The engineer has reported to the committee that the number of units sold during February was 14,190, being an increase of 3,070 compared with the output of February, 1896.

St. James's (Westminster).—The Works Committee at last week's meeting reported that they had considered a letter from Mr. J. Taylor, of the Office of Works, stating, on behalf of the Prince of Wales, that one of the electric light lamps recently erected in Pall Mall interfered with the uniformity of the lighting arrangements to the entrance of Marlborough House, and asking the Vestry to affix another electric light lamp on the east side of the entrance, in order to make the lighting uniform. The Vestry decided to accede to the request, subject to satisfactory arrangements being made with the Electric Light Company as to the wiring and lighting of the lamp.

Stirling.—At last week's meeting of the Police Commissioners, it was reported that Prof. Kennedy considered impracticable the proposed utilisation of the water supply at Touch in connection with the electric lighting of the burgh, and the Lighting Committee resolved to adhere to their former resolution to proceed with the extended area as recommended by the engineer. The Committee's recommendations were agreed to.

Taunton.—The electric lighting accounts for the year ended December 31st, 1896, show that the expenditure was £2,115 and the income £2,985, enabling £870 to be carried forward, with an additional £50 received for premiums, but £586 had to be applied to pay interest upon the mortgage debt, thus leaving a balance of £334.

Walsall.—The total number of consumers supplied on March 31st last was 79. The total number of units generated at the station during the month was 11,090. The total output from the main generators was 10,389 units. The total from the transformers was 8,340 units. The total registered on the meters was 6,118 units. The net income for the month was £135 2s.

Wandsworth.—The Putney Local Committee, at a meeting of this Board of Works, on 14th inst. reported the receipt of notice from the County of London Electric Lighting Company of intention to lay electric conduits in Chartfield Road. It was decided to offer no objection subject to the conditions agreed upon.

West Ham.—Upon the recommendation of the Highways Committee, the rentals for electric light meters are to be 2s. 6d. per quarter per 15 lights, 3s. per 30 lights, and so on up to 17s. 6d. per 500 lights.

Winchester.—The *London Gazette* for April 20th contains notice signed by the Town Clerk, to the effect that the Corporation intends to transfer its electric lighting order to the Winchester Electric Light and Power Company, Limited, for a period of 42 years.

Windsor.—The Windsor Electrical Installation Company, Limited, have resolved to increase their capital to £25,000, in order to enlarge the plant, to extend the mains, and to meet the increasing demand for the electric light. The company have now put down five miles of mains, and installed 2,770 8-candle-power lamps or their equivalent.

Witham.—Mr. G. A. Kuner, electrical engineer, of Witham, is arranging the preliminaries for the establishment of an electric lighting company for Witham and district, the proposed capital being £1,000. The shares have all been guaranteed to be taken up privately, and application will be made at once to the Board of Trade for a provisional order. Mr. Kuner, who has already got an electric lighting plant for one hundred lights in operation, will be the working manager and secretary of the company, and as soon as the provisional order is obtained, this plant will be augmented very considerably.

Wolverhampton.—The Town Council is to apply for sanction to a loan for £7,830 for the proposed electric lighting extensions, and £882 over-spent on previous capital account.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Belfast.—The Council met in Committee on 12th inst., to consider the report presented by the Special Committee appointed in reference to electric traction. The matter was referred back to Committee with instructions to negotiate with the Tramways Company "upon the basis of the Company's own third alternative slightly amended."

Birkenhead.—A special meeting of the Birkenhead Town Council was summoned for yesterday week to consider a report by Mr. James Ross, of Birmingham, as to the terms upon which he would be prepared to instal a system of electric trams in Birkenhead. Mr. Ross proposes to form a new company, embracing the two companies now operating in Birkenhead and Wirral, and at once proceed to lay down and construct an electric system covering, in the first place, all the existing routes on the system of the overhead wire. The Corporation on its part to grant to the company a lease or franchise of the tramways for a period of twenty-one years, to date from one year after the date on which the company are put in possession of the streets and enabled to commence the work of construction.

Coventry.—The Coventry Electric Tramways Company gives notice in the *London Gazette* that during the progress of their extensions Bill in Parliament, an alteration has been made in the site for the proposed generating station which will now be situate near the Coventry canal, and will have a frontage on the Stoney Stanton Road of 20 feet. The area of the site which will be purchased from the Coventry Corporation is about 1 acre 3 roods.

Douglas Southern Electric Tramway.—Since last season, says the *Isle of Man Times*, the Southern Electric Tramway, which then had its temporary terminus at Kirstal, has been extended to Port Soderick. The extension, which involved the filling in of a deep gully, is about three-quarters of a mile in extent, making the total length of the completed line—from Douglas Head to Port Soderick—about 3¾ miles. Besides this extension, the line has been considerably improved by the levelling down of its steepest gradient. The road is for the most part cut out of the face of the cliffs, and hundreds of feet below the waves break against one of the boldest coasts in the United Kingdom. Lovely bays and inlets indent the coast line from the starting point at Douglas Head to the terminus at Port Soderick. The tramway runs over the three steel bridges; one at Pigeon Stream, 120 feet long, supported on two piers; one at Walberry, 256 feet long, two spans with a centre pier; and the third at Horse Leap, 120 feet long of a single span. At present it is a single line with eight loops or passing places, ten with the finishing loops. One of the features of the line is that there is hardly any straight line in it, the route curving in and out, as it passes through and over bold headlands, in serpentine fashion. The line is worked on the overhead trolley system. The station for generating the electricity used is conveniently situated along the line and is completely equipped. The car shed at Little Ness is a corrugated building, 93 feet long and 40 feet wide, holding 16 cars—eight motor cars and eight trailers. As we stated, when describing the system last year, the power station is at Pigeon Stream, and is a two-story building, the engines and dynamos being on the ground floor and the boilers up above. There are two Babcock and Wilcox tube boilers, each of 120 H.P., working at a pressure of 120 lbs. There are two engines by Browett, Lindley and Co., of 130 H.P. each, which run at 240 revolutions a minute. The dynamos run at 650 revolutions a minute, with an out-put of 100 kw. at a pressure of 500 volts. There are 16 cars, each capable of seating 78 passengers. They are of the American type, and on the lower floor are fitted with seats running completely across the car, the entrance being made from either side, as both sides of the car are completely open. The roof is fitted with garden seats. The line was opened for the Easter holidays, and then closed until Whitsuntide when it will be opened for the season.

Dublin.—A special meeting of the Corporation was summoned for 15th inst. to consider proposals from the Dublin United Tramways Company with regard to the construction of certain new lines; and also a memorial from the Dublin and Lucan Steam Tramway Company in reference to the use of electric traction. As the number of members present did not constitute a quorum, the meeting fell through.

Electric Motor Tandem.—At the Catford Cycling Club Sports on Good Friday great interest was centred in a trial with an electric motor tandem which was in charge of Messrs. Dacier & Hunter, who kept up a great speed throughout, and succeeded in beating all previous records for all distances over two miles to six miles, the length of the test, the six miles being covered in 10 minutes and 34 seconds, which is 28⅘ seconds inside the world's record for any class of machine. It was stated the electric motor tandem had been tried capable of covering 40 miles an hour.

Halifax.—The Tramways Committee have not yet decided upon the details of the scheme, which, according to the *Halifax Guardian*, will not be settled until after their proposed visit to some of the larger towns where electric tramways are in operation. In the meantime, however, some important matters have been practically agreed upon with considerable unanimity by the members of the Tramways Committee. One of these is in reference to the character and size of the cars. The feeling of the committee on the subject is strongly in favour of a light car, affording seating capacity for from twenty to thirty people. The large piece of land at Mile Cross, recently purchased by the Corporation, is to be used as a tramway depôt, and not as an auxiliary electric station. However much the system may develop in Halifax within the next ten years, it is expected that the whole of the power can be generated at the Corporation electric works in Foundry street.

Laxey to Ramsay.—The Bill for the proposed electric tramway from the Laxey terminus of the Douglas and Laxey line, to Ramsay was before the Legislative Council last week for second reading and evidence was taken regarding the scheme.

Leeds.—The sub-committee which has charge of the works in connection with the electric tramway from Roundhay to Kirkstall recently reported that the boilers were on their beds at the generating station, the materials for the tram-shed roofs would be delivered before Easter, and the work of erecting them would be commenced immediately after. Satisfactory progress was also being made in regard to the engines, dynamos, and cars. The whole of the bonding of the rails on the Roundhay section from the Canal Gardens to the police-station at Sheepscar had been completed; and of the whole length from Roundhay to Kirkstall there only remained a very small portion to be bonded. The conduit for the electric cables from the Canal Gardens to the police-station at Kirkstall, with the exception of about 500 yards in Kirkstall Road, was completed, and the remainder would be finished immediately after Easter. About two miles of pipes had been laid since the March meeting. Of the 329 poles to be fixed, 280 had been erected. The electric cable had been placed in the conduit in Briggate, the greater portion of North Street, and Roundhay Road.

The Tramways Committee has appointed a sub-committee to consider the appointment of a staff for the electric power station in connection with the new electric tramways.

Speed of Electric Tramcars.—The Board of Trade has granted a small concession to the Dublin Electric Tramway Company by a reduction of ten minutes in the time allowed for running the

trams between Dublin and Dalkey. The shortest time according to the present arrangement for making the journey to or from Haddington road to Dalkey is one hour and ten minutes. The present time is available for a month, when, it is thought probable, a further reduction will be made. The tramway company have arranged to run cars in future every six minutes. Second couplings have been provided for all the carriages now, according to the requirements of the Board of Trade, which made it obligatory on the company to run no two carriages together without the second coupling.

Taunton.—The Mayor has received a letter from Messrs. Reed and Co. solicitors, stating that it is proposed to construct an electric tramway in Taunton, and the statutory notices will be served in due course. The communication was referred to the Streets and Highways Committee and the Electric Lighting Committee, who will jointly consider it. A Company has been formed for the purpose of the scheme.

The Walker Traction System.—In view of the interest centreing around the subject of electric tramways or light railways, Messrs. Laing, Wharton & Down, Limited, of New Bond Street, have placed before us particulars of some of the apparatus, etc, which they are now supplying for this purpose. The firm are acting as British representatives of the Walker Co. of America, the well-known Railway Motor and Generator Manufacturers. The speciality of this Railway Motor, apart from high efficiency and great mechanical strength coupled with superior protection, is claimed to be the method of suspension, which is so contrived that the weight of the motor is entirely borne by springs, thus saving the rails from the heavy hammer blow common to other systems, and at the same time adding greatly to the life of the armature. We understand that another advantage claimed for this system is that the torque of the armature is transmitted through springs, thus making the starting particularly smooth; an improvement greatly appreciated by the passengers. The controller used for operation on the series-parallel method does away entirely with the magnetic blow-out by having a spark-annulling cylinder on which the spark is broken by 32 air gaps in series. This is said to be both economical and reliable, and particularly safe and quick in working. The trolley collector consists of a roller instead of the ordinary V grooved wheel, thus permitting of simple overhead construction (especially at points and turnouts) and high speed working.—We would refer our readers to Mr. Eck's paper on this system which appears in our other columns.—Messrs. Laing, Wharton & Down have also given special attention to the matter of trucks and car-bodies for all services, representing the well-known firm of J. G. Brill & Co., of Philadelphia. Two handsome cars of their manufacture are now on exhibition at the Royal Aquarium. The overhead line requires special apparatus and treatment to secure good results, and the firm offer a full line of these goods in drop forged steel and aluminium bronze with Medbery insulation. To secure high efficiency it is now recognised that the return line must have good conductivity, and the firm anticipate that the 14 miles of track they are now bonding at Leeds will give results better than any existing line.

Wolverhampton.—A meeting of the Tramway Committee of the Corporation was to be held on 14th inst., to consider the new proposal of the British Electric Traction Co. relative to the Birmingham, Wolverhampton, and District Tramways.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
West Indies—		
Puerto Plata-Martinique	Dec. 19th, 1895 ...	...
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Jamaica-Colon	Feb. 6th, 1897 ...	...
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Benguela-Mossamedes ...	April 14th, 1897 ...	...
Hong Kong-Macao	April 20th, 1897 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Saigon-Bangkok ...	April 14th, 1897 ...	April 15th, 1897.
	April 18th, 1897 ...	April 19th, 1897.

April 7th, 1897.—Katarina-Larissa route impracticable.

April 9th, 1897.—Telegrams for Ecuador subject to censure at Guayaquil.

April 19th, 1897.—Chio-Syra route impracticable.

April 19th, 1897.—During war between Turkey and Greece, cable between Trieste and Corfu cannot be used for messages for Turkey; they must be sent *vid* Bosnia, Montenegro and Servia.

The Ottoman Government announce that messages in secret language may not be sent to the Greek Minister and Consul in Turkey. They are to be in plain language.

City Commissioners of Sewers and the Post Office.—Last week the Streets Committee submitted a report to the Commissioners in reference to applications from the Post Office authorities for permission to take up carriage and footways in the City for the purpose of laying telegraph wire pipes. It appeared from correspondence between the Committee and the superintending engineer of the Metropolitan Postal District, that the intention was to use certain pipes both for telegraphic and telephonic purposes. As the Committee objected to the latter, they recommended, and it was decided, to apply to the Treasury to institute an inquiry into the action of the Post Office authorities in constructing underground circuits, and allowing them to be used by the National Telephone Company for telephonic purposes without the consent of the Commissioners.

Earthquakes and Submarine Cable Interruptions.—Prof. John Milne writes to the *Times* under date April 12th with reference to seismic surveys, and we make the following extracts:—"One feature connected with seismic disturbances in general is, that their origins are more numerous beneath the sea than they are upon land, and there are undoubted cases where they have been accompanied by the interruption of submarine cables. Several instances may be taken from the Gulf of Corinth, where severe earthquakes have been felt, and simultaneously cables have been broken. Soundings taken along these lines of rupture have shown that after the earthquake there have been considerable increases in depth. In one instance this exceeded 400 fathoms. At more than 1,000 miles distance from the scene of one of these disasters, but 11 minutes later, the unfelt movements due to the initial impulse were definitely recorded. Very many cable interruptions are apparently due to submarine landslides, and there are strong reasons for believing that in many instances these are brought about by the shaking and dislocation caused by submarine earthquakes. The importance, especially for colonies whose only material connection with the mother country is a strand of wires, of being able to attribute the breaking of these to its proper cause, is a matter deserving consideration. The Australian colonies have twice been isolated from the remainder of the world by the sudden failure of their cables. The effect of this on trade was probably considerable, whilst the fact that on one of these occasions the naval and military reserves were called upon, indicates that a fear existed that cable interruption might not be unconnected with the operations of war. Subsequently it was learned that the ruptures were the result of submarine seismic or volcanic action, a fact which in all probability would have been known at once had those colonies been provided with instruments capable of recording unfelt earthquakes. The importance of establishing seismographs round many of our oceans, partly for determining when cables have been destroyed by seismic action and partly for the purpose of localising submarine *foci*, to be avoided when cables are being laid, is a matter that appeals not simply to the cable engineer, but to the public."

Manchester Telephones.—The National Telephone Company have now completed their system of underground wiring in the city of Manchester. It is justly claimed by the company that as a consequence of the abolition of the overhead wires the appearance of the city is greatly improved. The total mileage of wires taken down inside the city is over 1,500. The company has 5,000 subscribers and a staff of 130 employés.

Submarine Cable to a German Colony.—From a Berlin telegram we gather that "it is reported that the plan of connecting German South West Africa with the telegraph system of the Cape Colony by a cable starting from the southern frontier on the Orange River has been abandoned, on the ground that the scheme presents difficulties, and would make telegraphic communication dependent upon the English. The scheme has been rejected in favour of a plan to connect Swakopmund with the submarine cable from Mossamedes to Cape Town, the cable being the property of a private company." This change shows very little confidence in the privacy of telegraphic communication controlled by England. From such a point of view, we do not, however, see what advantage is to be gained by substituting Swakopmund for Cape Town, as the submarine cable which at present joins up Mossamedes is also in English hands. However, the scheme is to be encouraged, as the landing place selected is in the immediate vicinity of Walfisch Bay, a British possession which, thanks to German enterprise, will thus be furnished with telegraphic communication. *Apropos* of this, we may remark that the cable from Mossamedes, northward to England, has just broken down.

The Municipalisation of the Telephone.—A deputation of the Town Council of Glasgow had a conference on 13th inst. in the Rutland Hotel, Edinburgh, with representatives of Edinburgh Town Council with reference to the granting of Government licenses to municipalities for the working of the telephone within their boundaries. In the course of the conference the Glasgow representatives explained the action they had taken in reference to the telephone, the way things were managed in Continental cities, and the advantages which would accrue if municipalities received licenses from Government. The conversation which followed the statements made on behalf of Glasgow is understood to have shown that the Edinburgh Corporation representatives were all but unanimous on the question.

Telegrams in War Time.—The following notice, which has been issued by the Bureau International des Administrations Telegraphiques of Berne, shows us of how little value the present landline routes to India and the East would be should England at any time become involved in war. As to the existing cable routes, we have often dwelt on the ease with which they could be interrupted:—"Berne, April 19th, 1897.—Austrian Administration announces that,

owing to the commencement of the war between Greece and Turkey, telegrams transmiting through Austria, with destination in Turkey, can no longer be sent by the Trieste-Corfu cable, but only *vid* Bosnia, Montenegro, or Servia. The Ottoman Administration announces that by decision of the Imperial Government, the exchange of telegrams in secret language with Greek Minister or Consuls is prohibited, and must be sent in plain comprehensible language." To this should be added the information that both cables from Chio to Syra were interrupted on the breaking out of the war.

Venezuelan Telegraphs.—The *Glasgow Herald* says:—"Telegrams from Caracas state that the New York syndicate which has for some time been negotiating with that object in view, has secured from the Venezuela Government a practical telegraph monopoly, which is also to include the same privileges with regard to telephonic communication in the Republic. The monopoly is granted in the first instance for 30 years, subject to renewal under certain conditions. As the syndicate includes a large German element, it may not be inappropriate to add that in another quarter of the world German telegraph enterprise has not been so successful, the German Government having resolved to give up its idea of connecting German South-West Africa with the Cape telegraph lines, on the ostensible ground that this would place them to a considerable extent under British control."

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—April 27th. The Corporation invite tenders for an electrical storage battery consisting of 125 cells of 400 ampere-hour capacity, also for battery regulating switches. City Electrical Engineer, Mr. A. Blackman, Cotton Street.

Aberdeen.—April 27th. The Corporation want tenders for the supply for one year of electricity supply meters, house fuse boxes, and house concentric armoured service cables. City electrical engineer, Mr. Alfred Blackman, Cotton Street, Aberdeen.

Belfast.—May 6th. The Electric Committee want tenders for the supply and erection of boilers, batteries, overhead traveller, supply and laying of cables, conduits, junction boxes, and various plant, apparatus, and work in connection with the new electric lighting scheme. Electrical Engineer, Mr. V. A. H. McCowen, Central Station, Chapel Lane, Belfast. See our "Official Notices" for further details.

Belgium.—April 29th. Tenders are being invited by the Provincial Government Authorities at Liège for the concession, maintenance, and working of an electric tramway on the overhead-conductor system, between Chenée and Grivegnée. Tenders to be sent to the Gouvernement Provincial à Liège.

Blackburn.—May 8th. The Corporation invites tenders for the supply and erection of electric tramway equipment including two dynamos, switchboard, posts, and bracket arms, overhead line equipment, underground cables, &c., &c. Consulting engineer, Mr. E. M. Lacey, 10, Delahay Street, Westminster, S.W.

Dundee.—May 6th. The Gas Commissioners want tenders for arc lamps, pillars, Lancashire boiler, engine and dynamo, accumulators, switching gear, &c. City Electrical Engineer, Mr. W. H. Tittensor. See our "Official Notices."

France.—Tenders are at present being invited by the Municipal Authorities of Teste de Buch (Gironde) for the electric lighting of the public streets of the town. Tenders to be directed to La Mairie de Teste de Buch (Gironde).

Malta.—May 4th. The Receiver-General and Director of Contracts at Valetta invites tenders for a 200 kw. steam alternator, a steam engine to drive same (direct connected), also a water tube boiler. Particulars may be obtained upon application to the Superintendent of Public Works in Malta, or the Crown Agents for the Colonies, Downing Street, London.

Roumania.—August 20th. Tenders are being invited by the General Direction of the Roumanian Posts and Telegraphs in Bucharest for the supply of 55,000 porcelain (double-bell) insulators. Tenders to be directed to the Direction Générale des Postes et des Telegraphes, Bucharest.

Spain.—June 8th. The Spanish Ministry of Public Works in Madrid is inviting tenders for the concession for a projected electric tramway between Barcelona and its suburbs. Tenders to the Direccion Generale des Obras Publicas, Madrid.

St. Pancras.—April 27th. The St. Pancras Vestry want tenders for the wiring, &c., in connection with the electric lighting of the Whitfield Street Baths and Washhouses.

CLOSED.

Brighton.—The Town Council has accepted the tender of the Babcock & Wilcox Company, for the supply and fixing of three water-tube boilers at the electricity supply works, at a cost of £3,100. The Fowler-Waring Cable Company have secured the order for the supply of electric light cable and jointing sundries for one year.

Cardiff.—The Lighting and Electrical Committee has accepted the following tenders for the electric lighting extensions to Cowbridge and Cathedral Roads:—Cables, British Insulated Wire Co., Limited, £576 odd; transformers, Crompton & Co., Limited.

Morecambe.—The Electric Lighting Sub-committee's recommendation, which came before the District Council on 12th inst., and was accepted, included the placing with Messrs. T. Parker, Limited, of Wolverhampton, the order for the whole of the required electric lighting plant. Detailed estimates of the electric light plant, &c., had been prepared and forwarded to the Local Government Board, for their sanction to the loan of £26,000 to carry out and complete the works. The whole of the promenade will be lighted by means of 75 arc lights.

Newington.—The Vestry has accepted the tender of Messrs. Sharpe & Piper, amounting to £1,750, for an electric lighting installation at the baths, including wiring, lamps, and all necessary fittings.

Plymouth.—The Council considered the tenders sent in for electrical plant in connection with the combined lighting and traction scheme on 14th inst., and accepted those marked with an asterisk in the following list. There was a brief explanation made by Mr. Councillor Willoughby in moving the confirmation of the Electric Lighting Committee's minutes, to show that the committee in accepting the marked tenders had no interest of their own to serve in any way, but were influenced merely by the desire to have the best plant for the town, and that which would be likely to give the best results:—

Contract No. 1.—(Steam alternators, dynamos, &c.)

	£	s.	d.	
Crompton & Co., Ltd.	11,783	0	0	
Siemens Bros. & Co., Ltd.	12,750	0	0	
Brush Electrical Engineering Co., Ltd.	12,979	7	0	
*S. Z. de Ferranti, Ltd.	13,401	14	0	(Includes racking gear for field magnets, &c.)

Contract No. 2.—(Boilers, piping, pumps, &c.)

	£	s.	d.
*J. Musgrave & Sons, Ltd.	7,757	0	0
Hick, Hargreaves & Co., Ltd.	7,995	0	0
A. Anderson & Co.	8,504	12	2
D. Adamson & Co.	9,356	10	0

Contract No. 3.—(Accumulators.)

	£	s.	d.	Maintenance for 10 years at per annum. £	s.	d.
Pritchetts & Gold	1,377	0	0	72	0	0
*A. B. Pescatore	1,554	12	0	75	0	0
Chloride Electric Storage Co.	1,620	0	0	140	0	0
I.E.S. Accumulator Co., Ltd.	1,992	17	0	175	10	0
E.P. Storage Co., Ltd.	2,271	11	0	150	0	0
Epstein Accumulator Co., Ltd.	2,409	5	5	169	13	0

Contract No. 4.—(Crane, &c.)

	£	s.	d.
*Taylor & Hubbard	438	0	0
Littlejohn & Service	467	0	9
Willcocks & Sons	472	0	0
Bedford Engineering Co.	485	0	0
Carrick & Ritchie	580	0	0
Ransomes & Rapier	690	0	0

Contract No. 5.—(Switchboards, &c.)

	£	s.	d.	
Edison & Swan Co., Ltd.	1,505	0		(Alternative design
*S. Z. de Ferranti, Ltd.	1,572	0	0	

Contract No. 6.—(Cables, &c.)

	£	s.	d.
Fowler-Waring Co., Ltd.	6,034	10	0
W. T. Glover & Co., Ltd.	6,820	0	10
*British Insulated Wire Co., Ltd.	6,933	10	5
Callender & Co., Ltd.	7,407	16	0
W. T. Henley & Co., Ltd.	7,552	18	9
Siemens Bros. & Co., Ltd.	7,586	0	0

Contract No. 8.—(Transformers, &c.)

	£	s.	d.
*Edison & Swan Co., Ltd.	964	12	0
Johnson & Phillips	1,037	16	0
Crompton & Co., Ltd.	1,053	0	0
Siemens Bros. & Co., Ltd.	1,065	0	0
Brush Electrical Engineering Co., Ltd.	1,127	5	0
J. Fowler & Co. (Leeds) Ltd.	1,143	0	0
Electric Construction Co., Ltd.	1,302	0	0
S. Z. de Ferranti, Ltd.	1,508	18	0

Contract No. 9.—(Arc lamps, &c.)

	£	s.	d.
*Crompton & Co., Ltd	2,380	2	0
Brush Electrical Engineering Co., Ltd.	2,512	10	0
General Electric Co., Ltd.	2,539	18	6
Brockie-Pell Arc Lamp, Ltd.	2,703	6	8
Johnson & Phillips	2,780	5	6
Siemens Bros. & Co., Ltd.	2,884	10	0
Davey Electrical Co., Ltd.	2,996	5	11

Taunton.—The Electric Lighting Committee have accepted the tender of Messrs. Robinson, of Bristol, for oils for the ensuing twelve months, and that of Messrs. Babcock & Wilcox for the supply of a new 100 H.P. boiler for £400.

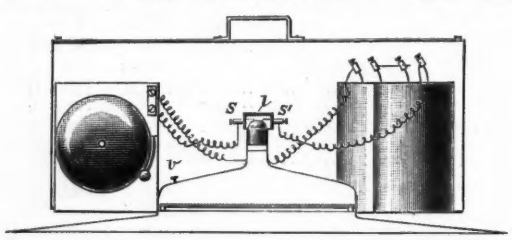
NOTES.

Lectures.—Before the Belfast Philosophical Society on 14th inst., two communications were given conjointly by Dr. De Smolan and Dr. Beattie, of the University Physical Laboratory. The subjects treated were "Electrical Phenomena produced by Röntgen Rays" and "Photographic and Electrical Effects Due to Uranium."

Personal.—Mr. Robert T. Turnbull has been appointed engineer and manager of the New Zealand Electrical Syndicate, Limited, supply station, Wellington.

The Electrolytic Separation of Metals.—The influence of osmotic pressure has recently been studied by R. Pauli in connection with the separation of metals by means of electrolysis when soluble anodes are used. The author notes that in the Daniell type of cell, the solution of the one electrode and deposition of a metal on the other, depends upon the relative osmotic pressure of the two metals towards the electrolyte used. If a solution of mixed salts surround the cathode, that metal will be first deposited which, for the given electrolyte, exerts the least osmotic pressure. A separation of metals is thus possible without use of dynamos: and as a current will be at the same time produced in the depositing cell, this method may in some cases be cheaper than the usual one. Pauli describes the above in the *Electro-Chemiker Zeitung*, Vol. 3., page 180.

A New Fire-Damp Indicator.—This recently patented fire-damp indicator, which is described in the *Engineering and Mining Journal* by Carl Pixis, consists of a vessel cylindrical above and conical below, which is closed at the conical end by a porous plate of burnt and unglazed clay, about $\frac{1}{16}$-inch thick, which carries on top a cylinder of $1\frac{1}{2}$-inch diameter. This is closed by a plug of hard rubber moving easily up and down without friction, and weighing not more than 2 or 3 grammes. By the diffusion of the light carburetted hydrogen gas into this funnel-shaped vessel, the pressure in it will be raised because the current of the air through the porous plate will be interrupted, and the plug will be slightly moved upwards. A light ring of platinum, *l*, is fixed on the plug, and serves to close an electric circuit,



s s', by which an electric bell is rung. In order to increase the effect, a large accumulating funnel can be fixed underneath the porous plate, as shown. The apparatus, including the dry battery and the bell, but not the porous plate, is set in a portable and air-tight box, provided with a handle on the cover. In this way it can be readily carried to any part of a coal mine. It gives at the sudden or gradual appearance of dangerous gases a signal which will give alarm before they become mixed with the air, and dangerous. The whole apparatus occupies a space of not over 18 inches in width and about 8 inches in height. The vessel is provided with a screw, *v*, by which air can be admitted when a change is needed.

The Commercial Electrolysis of Fused Salts.—Those who are interested in electrolysis are aware that it is expected that the feasibility of electrolysing fused salts at a price commercially possible will soon be demonstrated. One of the numerous processes which have been proposed is due to Vautin, and at Modane, in France, a lengthy trial has been given to it. Molten lead forms the cathode in this process. The unsatisfactory results obtained in earlier experiments were due to the formation of sub-chlorides and to the liberation of the sodium in globules, which did not alloy rapidly with the molten lead. These difficulties are overcome by electrolysing a definite mixture of sodium and lead chlorides, the bath being continually fed with the same. The anodes are formed of receivers containing lead, and receive only part of the current. A portion of the liberated chlorine acts on the lead, and the lead chloride formed diffuses into the bath. By regulating the current passing through the molten lead anode, the amount of lead chloride formed can be increased or diminished. The best current density is 0·7 amperes per square foot, and produces 0·081 kilo. of Cl. and 0·054 kilo. of sodium per H.P. hour. An E.M.F. of 7 volts is required. Peroxide of lead, and alloys of sodium or barium with tin or zinc, may also be obtained by this method. For further details, consult the paper by C. Cheneveau in the *Revue de Physique et de Chimie.*, Vol. 1, pages 55 to 62.

Book Received.—"Lean's Royal Navy List" (quarterly) for April, 1897, has been published by Messrs. Witherby and Co., 326, High Holborn, W.C. (price 7s. 6d.). The book, which is edited by Lieut.-Colonel Francis Lean, contains an enormous quantity of information regarding the British Navy and the officials employed in connection with same, which information is of special interest at the present moment when so much importance attaches to the movements of our fleet. Full details are given of our famous battleships now in service, and ships which are at present in course of construction or ordered to be built for the Royal Navy.

Properties of American Bituminous Coals.—In tests given by Mr. Bryan, of Southern Illinois coal—one of the principal American bituminous coals—the maximum B.T.U. per pound is set down as 12,190, the ash being 7·02 per cent.; the minimum result is 9,336 B.T.U., with 16·50 per cent. for ash. The largest ash constituent was 18·02 per cent. of miscellaneous coals. Pocahontas, about the best fuel in America, gave 13,029 B.T.U., with only 5·6 per cent. of ash. In a long list of fuels only some half dozen had less than 10 per cent. of ash, and the notable feature in these coals seems to be the high percentage of ash, ranging up to as high as 21·35. These fuels are classed as low grade fuels, the lowness of quality being largely due to the heavy ash constituent, and also very largely to the large amount of contained moisture, ranging from $6\frac{1}{2}$ to $12\frac{3}{4}$ per cent. In the miscellaneous list Pocahontas shows only 1·20 per cent. of moisture. Useless matter amounts, therefore, to only 6·8 per cent. in this coal, while in other coals we find it as much as from 20 to 28 per cent. Indeed, as might be logically expected, the value of a coal is simply measured by its useful constituents, though the water present is to be debited really with more than its mere weight for it detracts from the value of a fuel in a double sense, absorbing heat in its vaporisation. Mr. Bryan is an advocate for calorimeters for coal testing. He considers they show very concordant results, and ought to be used to determine the true commercial value of a fuel. In this connection it is well to consider also the facilities for getting rid of ash and clinker. For example, ash is largely alumina, and as such it adds its quota in cement manufacture which is burned with free fuel and all the contents of a kiln are ground together. Assuming a proper admixture of lime to satisfy the added alumina it is no serious loss to buy the ash in fuel at five shillings per ton and sell it as cement at twenty-five. Even the heat value of a coal is not of necessity its absolute commercial value.

Search Lights and Coast Defence.—On 19th inst., experiments were carried out at Sheerness Garrison to test the efficiency of the electric search light arrangements in connection with the defence of the entrance to the River Medway. The gunboats *Bustard* and *Bouncer*, and three War Department steamers, were detailed to steam into Sheerness Harbour under cover of darkness. By aid of the search light, the vessels were kept under observation until they had rounded Garrison Point fort.

Institution of Electrical Engineers.—The next meeting of the students of the above Institution will be held on Wednesday, April 28th, at 7.30, at 28, Victoria Street, S.W., when a paper will be read by Mr. F. Johnston, on "Accumulators."

Zinc.—Attention is drawn by the *Engineering and Mining Journal* to the rapid increase in the production of this metal, which exceeds the consumption, such disproportionate increase taking place both in Europe and America. The Silesian, Italian, and Spanish mines have all increased their output, and a Belgium company also is extending its works and operations. The complaint is now made that the general industrial activity in Europe has not been followed by the increase in the price of spelter, which has been shown in the case of almost all the other metals. There has been no agreement among producers for two years past, and production has not been limited. There is no prospect at present, says our contemporary, of a new convention. The world's production of spelter in 1896 is estimated at 418,460 long tons, an increase in five years of 62,615 tons, and in 10 years of 124,058 tons.

Society of Arts.—On Wednesday, April 28th, at 8 p.m., a paper on "Asbestos and Asbestic: with some Account of the Recent Discovery of the latter at Danville, in Lower Canada," will be read by Robert H. Jones.

NEW COMPANIES REGISTERED.

Canton (Wai pori) Mining and Electric Power Company, Limited (51,909).—Registered April 1st with capital £150,000, in £1 shares, to adopt an agreement with the New Zealand Minerals Company, Limited, to acquire, develop, turn to account, and work certain claims and mines at Waipori, N.Z., and to carry on the business of an electric light and power company. The subscribers (with one share each) are:—G. Kerr, 49, York Street, Portman Square, W., clerk; S. H. Stacey, 111, Grange Park Road, Leyton, clerk; A. E. Thompson, 26, Friar Street, S.E., clerk; G. Salter, Capworth Street, Leyton, clerk; W. Macdonald, 6, Belsize Park Terrace, N.W., clerk; E. Hessman, Suffolk House, E.C., gentleman; A. S. King, 3, Chesnut Avenue, Forest Gate, clerk. The number of directors is not to be less than three, nor more than seven; the subscribers are to appoint the first. Qualification £100; remuneration £150 each per annum (£200 for chairman), and a share in the profits. Registered by S. D. Stoneham, 2, St. Michael's House, Cornhill, E.C.

British Columbia Electric Railway Company, Limited (51,953).—Registered April 3rd with capital £250,000, in £10 shares, to adopt an agreement with the Colonial Railway and General Investment Company, Limited, and to acquire and take over and carry on the business of a consolidated railway company (incorporated by an Act of the Legisiative Assemble of B.C.). The subscribers (with one share each) are:—C. W. P. Slade, 11, Chesham Place, S.W., gentleman; E Welton, 58, Tufnell Park Road, N., gentleman; H. Frapwell, 45, Bishop's Road, S.W., gentleman; E. W. Mitton, jun., 34, Hamilton Road, Ealing, gentleman: E. C. Robson, 46, Brakespear's Road, Brockley, gentleman; G. B. Earnshaw, 6, William Street, Lowndes Square, gentleman; W. I. Hampton, 6, Auriol Road, West Kensington, gentleman. The number of directors is not to be less than five, nor more than seven; the first are F. S. Barnard, Horne-Payne, R. M. H. Payne, A. C. Mitchell-Innes, R. W. Laurie, G. P. Norton and R. K. Sperling. Qualification £500; remuneration £1,000 per annum and a share in profits divided. Registered office, 1 and 2, Great Winchester Street, E.C.

Taunton and West Somerset Electric Railways and Tramways Company, Limited (52,061).—Registered April 9th with capital £600 in £1 shares, to promote the construction of light railways and tramways in England, to equip, maintain, and work the same with electric, steam, horse, or other power, and to supply electricity. The subscribers (with 10 shares each) are:—C. J. Goodland, Taunton, merchant; T. S. Penny, Knowls, Taunton, merchant; H. J. Van Tromp, East Street, Taunton, clothier; W. H. Fisher, Elmhurst, Taunton, ironmonger; H. M. Cooper, Acacia House, Taunton, photographer; J. H. Bale, Elmgrove, Taunton, boot manufacturer; A. Goodman, Fernlea, Taunton, chartered accountant. The number of directors is not to be less than two nor more than seven; the subscribers are to appoint the first. Registered office, 3, Hammet Street, Taunton.

West Coast of America Telegraph Company, Limited (52,114).—Registered April 12th with capital £132,520, in £2 10s. shares, to acquire, take over, and carry on the business carried on by a company of the same name (registered in 1877), and to adopt an agreement with the said company and its liquidator and the Brazilian Submarine Telegraph Company, Limited. The subscribers (with one share each) are: J. D. Pender, Winchester House, E.C., gentleman; F. Wallers, 12, Tokenhouse Yard, E.C., merchant; W. St. J. F. Brodrick, 34, Portland Place, W., gentleman; F. Dawes, 50, Old Broad Street, E.C., solicitor; W. H. Axworthy, Queen's Ride, Barnes Common, gentleman; R. Collett, 19, St. Mary's Road, Harlesden, gentleman; F. L. Robinson, St. Winifred's Road, New Barnet, gentleman. The number of directors is not to be less than three, nor more than six. The subscribers are to appoint the first; qualification, £100; remuneration as fixed by the company. Registered office, 50, Old Broad Street, E.C.

Walter V. Scott & Co., Limited (52,120).—Registered April 13th with capital £5.000 in £1 shares to adopt an agreement with W. V. Scott, and to carry on the business of manufacturers of, and dealers in, electrical generators, electrical motors, or accumulators, lamps, fittings, elevators, &c. The subscribers (with one share each) are:—A. J. Vince, 97, Manor Street, Clapham, clerk; F. W. Loxton, Claude Villa, West Street, Leytonstone, clerk; C. M. Trevor, 48, Queen's Gardens, Hyde Park, W., solicitor; W. V. Scott, 33A, Earl's Court Road, S.W., electrician; A. T. H. Scott, 18, Rylett Crescent, Shepherd's Bush, clerk; M. M. Cousins, 118A, Cromwell Road, S.W., secretary; E. W. Browne, Prospect Place, Plaistow, clerk. Registered without articles of association by Paddison & Co., Suffolk House, Laurence Pountney Hill, E.C.

Gem Dynamo Brush Company, Limited (52,160).—Registered April 14th, with capital £3,000 in £1 shares, to acquire certain patents, to enter into an agreement with F. J. and R. Chaplin, and to carry on the business of manufacturers of and dealers in brushes for dynamo-electric machines. The subscribers (with one share each) are:—F. J. Chaplin, 395, Victoria Road, Aston, Birmingham, wire drawer; R. Chaplin, 233, Park Lane, Aston, Birmingham, wire drawer; S. Jevons, Minories, Birmingham, engineer; T. Birkmire, 70, Victoria Road, Aston, Birmingham, schoolmaster; S. Chaplin, 25, Vauxhall Road, Birmingham, wire drawer; W. H. Jevons, 7, Temple Row, Birmingham, solicitor; J. G. Wood, 39, Temple Row, Birmingham, solicitor. Table "A" mainly applies. Registered by Jordan & Sons, Limited, 120, Chancery Lane, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

St. James's and Pall Mall Electric Light Company, Limited (26,015).—This company's annual return was filed in March, when the whole capital of £200,000, in 100 founders' shares of £1 each, 19,980 ordinary shares of £5 each, and 20,000 preference shares of £5 each was taken up, and paid in full.

National Electric Light Company, Limited (29,992). This company's annual return was filed on March 8th. The capital is £100,000, in £5 shares (of which 100 are founders'); 10,846 ordinary and 100 founders' have been taken up, and the full amount called; £54,730 has been paid, and £15 has been paid on four shares forfeited.

Cuba Submarine Telegraph Company, Limited (4,710).—This company's annual return was filed on March 10th, when the whole capital of £220,000 in £10 shares (6,000 being preference), was taken up, and paid for in full.

Cowper Coles' Galvanising Syndicate, Limited (41,223).—This company's annual return was filed on February 17th. The capital is £2,000, in £1 shares (of which 500 are "A," and the rest "B"). All of these have been taken up, and 500 of each class considered as paid; £1,000 has been paid on the remaining "B" shares.

Hubert Grenfell, Limited (43,086).—This company's annual return was filed on January 22nd, when 10,000 ordinary and 1,345 preference shares were taken up out of a capital of £12,500 in 10,000 ordinary and 2,500 preference shares of £1 each. The ordinary are considered as paid, and £1 per share has been called and paid on the preference.

Notting Hill Electric Lighting Company, Limited (25,921).—This company's annual return was filed on March 23rd. The whole capital of £100,000, in 6,452 ordinary, 550 founders, and 2,998 ordinary preference shares of £10 each has been taken up, and the full amount has been called and paid.

Northampton Electric Light and Power Company, Limited (28,640).—This company's annual return was filed on March 15th. The capital is £50,000 in 10 "A" and 49,990 "B" shares of £1 each. The "A" shares have been taken up, but no calls made thereon, whereas 14,000 "B" have been subscribed for, and paid up in full.

Improved Incandescent Electric Lamp Syndicate, Limited (44,872).—This company's statutory return has just been filed. The capital of £700 in £1 shares has been taken up, and 400 are considered as paid; £1 per share has been called on the others, and £244 10s. has been paid, leaving £55 10s. in arrears.

I. E. S. Accumulator Company, Limited (44,731).—This company's annual return has just been filed; 55,000 shares have been taken up out of a capital of £100,000 in £1 shares; 50,000 are considered as fully paid, and £5,000 has been called and paid on the others.

Hartlepool Electric Tramways Company, Limited (49,734).—This company's statutory return has just been filed; 21 shares have been subscribed for out of a capital of £50,000 in £10 shares, but no calls have as yet been made.

Italian Electrical Light and Power Company, Limited (34,433).—This company's annual return has just been filed. 307 shares have been taken up out of a capital of £60,000, in £4 shares, and 300 are considered as paid. No calls have been made on the others.

Chelsea Electricity Supply Company, Limited (20,468).—This company's annual return was filed on April 6th. The capital is £200,500, in 34,000 £5 ordinary, 6,000 preference shares of £5 each, and 500 founders' shares of £1 each. All the founders' shares have been issued as paid; 26,000 ordinary and 6,000 preference shares have been taken up, and 6,666 ordinary are considered as paid; £5 per share has been called on the rest, and £126,670 has been paid.

Charing Cross and Strand Electricity Supply Corporation, Limited (29,122).—This company's annual return was filed on March 26th. The capital is £250,000 in £5 shares, and 40,000 shares have been taken up, and £200,000 called and received.

Incandescent Electric Lamp Company, Limited (39,316).—This company's annual return has just been filed; 1,200 ordinary and 100 deferred shares have been taken up out of a capital of £25,000 in £10 shares (of which 500 are deferred). £9 10s. per share has been called, and £11,400 paid on the ordinary shares, and the others are considered as paid.

International Telescriptor Syndicate, Limited (49,460).—This company's statutory return was filed on March 19th, when the capital of £10,000, in £1 shares, was fully taken up; 9,993 shares are considered as paid, and nothing has been received in connection with the others.

Julius Sax & Co., Limited (37,435).—This company's annual return was filed on January 14th. The capital of £20,000 in £10 shares has been taken up in full, and 1,993 are considered as paid. No calls have been made on the others,

CITY NOTES.

The Oriental Telephone and Electric Company, Limited.

The report of the directors for the year ended December 31st, 1896, to be presented at the third ordinary general meeting of the company, to be held at the Cannon Street Hotel, on Tuesday, April 27th, 1897, at 3.30 o'clock p.m., states that the revenue account shows a balance to credit of £9,826 transferred to profit and loss, which with £806 3s. 3d. brought forward from 1895, and deducting £2,858 8s., the amount of the interim dividend paid in October, leaves £7,773 15s. 3d. for disposal. The directors recommend that this sum should be dealt with as follows:—£5,716 16s. in payment of a final dividend of 8d. per share, free of income-tax, making 5 per cent. for the year; £1,427 5s. in part liquidation of the loss consequent on the compulsory expropriation of the Colombo exchange by the Ceylon Government; and to carry forward £629 14s. 3d. The revenues of the Indian companies show steady improvement. The accounts of the Bombay Company show a surplus of about Rs. 30,000, after providing for dividend, but the directors of that company deemed it advisable to make no increase in the rate, feeling that the business of the company might be somewhat affected during the current year, consequent on the dislocation of local trade by reason of the plague. The Telephone Company of Egypt has declared its usual dividend of 6 per cent. on its preferred shares, and the operations of the company in that country are being extended. The China and Japan Company has paid its debenture interest, and is making progress. The Hong Kong branch, which for many years showed unsatisfactory results, is now improving. The business in electric lighting, which the directors had hoped ere this would have become profitable to the company in India, has been much interfered with during the past year through the general retrenchment of expenditure owing to the severe famine and plague prevailing. Considering these adverse circumstances, the turn-over during the year has not been altogether unsatisfactory, giving hope that when the general trade of the country revives, this branch of the company's business will become more than self-supporting. The directors feel convinced that a development of electric lighting, and the use of electricity as a motive power must take place in the near future. The expenses written off in connection with this branch include outlays during the year at Bombay, Madras, and Rangoon, in addition to the expenses at the head office in Calcutta. It is hoped that this increased expenditure may be productive of good hereafter.

Eastern Extension Telegraph Company, Limited.

The report of the directors of the Eastern Extension, Australasia and China Telegraph Company, Limited, for the half-year ended December 31st last, to be submitted to the ordinary general meeting to be held at Winchester House on 28th inst., states that the gross receipts, including Government subsidies, have amounted during the half-year to £325,406, against £311,582 for the corresponding period of 1895. The working and other expenses, including £36,056 for cost of repairs to cables and expenses of ships, absorb £106,270, against £84,044 for the corresponding period of 1895, leaving a balance of £219,135. From this is deducted £4,177 for income-tax, £10,000 transferred to the fire insurance fund, and £31,895 for interest on debentures, debenture stock, and contribution to sinking fund, leaving as the net profit for the half-year £173,063, which, with £33,235 brought forward, shows an available balance of £206,298. One quarterly interim dividend of 1½ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount on 29th inst., making, with the interim dividends paid for the first half-year, a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1896, leaving £93,798, of which £75,000 has been transferred to the general reserve fund, and the balance of £18,798 is carried forward. In accordance with the provisions of the trust deed, 429 of the company's 5 per cent. Australian Government subsidy debentures, amounting to £42,900, were drawn on 5th inst. for payment at par on July 1st next. An arrangement has been concluded with the Spanish Government for extending, on a subsidy basis, the company's system in the Philippine Islands, by the laying of three short cables between Luzon, Panay, Negros and Cebu. As these cables will bring Iloilo (second only in commercial importance to Manila) into telegraphic communication with the rest of the world, it is expected that, while proving of great advantage to the Government, they will become feeders to the company's system. A contract has also been entered into with the Dutch Government for the manufacture and laying on account of the Government of two short cables in Netherlands-India.

The Indo-European Telegraph Company, Limited.

In their report for 1896, the directors have to express their deep regret at the loss of the valuable services of their late colleague, Major-General G. B. Tremenheere, who died last December, and who had been connected with the company since its incorporation. The company's revenue from all sources for 1896 amounted to £123,539 17s. 11d., as compared with £123,734 11s. 7d. for 1895, showing a decrease of £194 13s. 8d. The expenses were: on commercial and general account, £35,362 16s. 9d.; on maintenance account, £32,742 13s. 3d.; total, £68,105 10s., as against £67,820 10s. 4d. for 1895, an increase of £284 19s. 8d. Deducting the above expenses, taking credit for £6,871 17s. 11d. brought over from 1895, and debiting income-tax, there remains the sum of £60,204 3s. 2d. From this amount £10,000 has been placed to reserve, and that sum, together with £10,625 amount of interim dividend, have to be deducted, leaving a balance of £39,579 3s. 2d. The directors now propose the declaration of a dividend for the six months ending December 31st of 17s. 6d. per share, making, with the dividend already paid, 6 per cent., and a bonus of 20s. per share, both free of income-tax, making in all 10 per cent. for the year, carrying forward £7,704 3s. 2d. to the credit of 1897. As the shareholders are aware, the Telegraph Conference, at which this company was duly represented, was held last year in Buda Pesth. It was determined in the interest of the public and of uniformity, to assimilate the extra-European with the European *régime* in respect of counting figures and letters in plain language messages. This and some other measures in the same direction will not materially affect the company's receipts. The lines of the company continue to work satisfactorily, and the directors have introduced the Wheatstone automatic apparatus with the view of increasing the speed of signalling. The following directors retire by rotation, and offer themselves for re-election: John von Berenberg Gossler, Esq., and C. Holland, Esq. In case any shareholder should be unable to attend the general meeting, he is requested to fill up and return the enclosed proxy form, duly signed, so as to reach the company's office not later than 12.30 p.m. on the 26th instant.

Norwich Electricity Company, Limited.

The annual meeting of this company was held last Wednesday week at Norwich. The fifth annual report testified to a considerable increase in the number of consumers both for lighting and motive power, necessitating an addition to the generating plant and an extension of the premises in Duke Street. The cost of producing the current having diminished, the charge for current for lighting had been reduced by 12½ per cent., taking effect from January 1st. The revenue account showed a credit balance of £5,869 19s. 11d., from which must be deducted £780 for interest on debentures. The directors proposed to declare a dividend of 4½ per cent. free of income-tax, amounting to £1,645 18s. 11d., to place £2,500 to depreciation account, and to carry forward £944 1s. In the general balance-sheet the capital expenditure shows £65,661.

The Chairman moved the adoption of the report, and said the company had made a most gratifying advance. The income in 1895 was £5,845, while last year it was £9,470. The number of customers had risen from 450 to 675. The company was now on an extremely firm basis.

Mr. Wild seconded, and said that the singular prosperity of the company was due to the excellent management scientifically and commercially.

Edmundson's Electricity Corporation, Limited.—With a capital of £200,000 divided into 35,500 ordinary and 4,500 in deferred shares, all of £5 each, this company has been formed for the purchase and extension of the business of Edmundsons, Limited, engineers and electricians, of Great George Street, London; 20,000 of the ordinary shares are now being offered for public subscription, as will be seen from the prospectus, which appears in another part of this issue. The company is to enter into and carry out contracts and concessions for central station lighting in various cities and towns, and capital is required for these purposes. Mr. Francis E. Gripper, M.I.E.E., is the managing director, and the other directors are Messrs. J. R. Wigham, W. R. Davies, J. W. Edmundson, W. B. Hopkins, Hy. Wigham. The secretary is Mr. Frederick Payton.

Stock Exchange Notices.—Application has been made to the Stock Exchange Committee to allow the following to be quoted in the Official List:—Central London Railway Company—51,951 preferred half-shares of £5 each, £1 paid; 2,570 preferred half-shares of £5 each, £5 paid; and 54,521 deferred half-shares of £5 each, fully paid, in lieu of 2,570 fully-paid and 51,951 partly-paid shares now quoted.

The Oswestry Electric Lighting and Power Company, Limited.—This company held their annual meeting last week, Mr. A. Wynne Corrie presiding, when a dividend for the past year at a rate of 3 per cent. was declared. Messrs. Josiah Jones and Geo. Perks were re-elected directors, and Messrs. Williams and Nicholson were reappointed auditors.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending April 18th, 1897, were £845; week ending April 19th, 1896, £921; decrease, £76; total receipts for half-year, 1897, £16,684; corresponding period, 1896, £15,260; increase, £1,424.

The Liverpool Overhead Railway Company. The receipts for the week ending April 18th, 1897, amounted to £1,478; corresponding week last year, £1,151; increase, £327.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending April 16th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £1,951,

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, April 13th.	Closing Quotation, April 21st.	Business done during week ended April 21st, 1897. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	4½— 5½	4½— 5½	...	...
1,612,880£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	49 — 52xd	49 — 52	...	...
2,993,560£	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	93½— 94½xd	93½— 94½	94½	93⅝
2,993,560£	Do. do. Defd.	Stock	...	...	...	7⅝— 8½	7½— 8	7 9/16	...
130,660	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	15 — 15½	14⅝— 15½	14 11/16	...
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	113 —117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	...	3½— 3⅝	3½— 3⅝	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	162 —167	162 —167	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	10 — 11	10 — 11	...	...
5,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½— 4½xd	3½— 4½	...	...
5,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½xd	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 5,000 ...	50	4½%	4½%	4½%	105 —108 %	105 —108%	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	8⅝— 9½xd	8⅝— 9½	...	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6¼%	6¼%	...	17 — 17½xd	17 — 17½	17½	17
70,000	Do. 6 % Cum. Pref.	10	6 %	6	...	18 — 19 xd	18 — 19	18⅝	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	103 —106	103 —106	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	127 —130	127 —130	129½	129
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	%	17½— 18¼	17½— 18¼	18¼	18 3/16
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5%	100 —104	100 —104	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	101 —104	101 —104	103	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	127 —130	127 —130	...	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	100 —104	100 —104	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	101 —104	101 —104	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	107 —110	107 —110	...	...
280,800£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 3,000	25	4 %	4 %	4%	109 —112 %	109 —112 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	11 — 11½	11 — 11½	11 11/16	11 3/16
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	17 — 17½	17 — 17½	17 3/16	...
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	10 %	10%	24 — 25	24 — 25	...	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5%	102 —105	102 —105	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10%	55 — 58	55 — 58	...	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6%	107 —110	107 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2¼	2 — 2¼	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5¼%	5¼%	6¼— 6½	6⅜— 6⅝	6½	6⅜
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	16	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6½	6 — 6½	6⅛	...
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	102 —105	102 —105	103½	103
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	...	⅝— ¾	⅝— ¾	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4%	107 —110	107 —110	...	...
11,839	Reuter's Ltd.	8	nil	5 %	...	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	138 —143	136 —141	...	...
58,880	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3 — 3½	3 — 3½	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	100 —105	100 —105	...	...
15,509	West African Teleg., Ltd., 7,501 to 23,109	10	nil	4 %	...	5 — 6	5 — 6	...	...
238,200£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 —104	101 —104	...	...
30,000	West Coast of America Teleg., Ltd.	10	nil	nil	...	⅜— 1½	⅜— 1½	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	103 —108	103 —108	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	3 %	3 %	...	7⅜— 8½	7½— 8	7 13/16	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	6½— 6⅝	6½— 6⅝	...	...
33,129	Do. do. do. Def. Ord.	7½	1 %	1 %	...	1⅝— 2½	1½— 2	...	...
165,200£	Do. do. do. 5 % Debs. "A," 1880 Red.	100	6 %	6 %	...	112 —116	112 —116	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	...	109 —113	109 —113	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¾%	...	⅞— 1½	⅞— 1½	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	11 — 11½	11 — 11½	11½	...
4,569	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	9½— 10½	9½— 10½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,600 ...	100	5 %	5 %	...	107 —110	107 —110	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7%	107 —112	107 —112	...	...
164,200£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6%	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	10½— 11½	10½— 11½	...	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	8⅞— 9½	8⅞— 9½	9⅛	9 1/16
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	4½%	4½%	112 —115	112 —115	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	21 — 22	22 — 23	22⅜	22
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½— 17½	16½— 17½	...	...
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	132 —136	132 —136	...	...
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	nil	nil	11½— 12	12 — 12½	12⅜	11⅞
20,000	Do. do. do. 6% Pref., 40,001—50,000 ...	10	...	6 %	6 %	14½— 15	14½— 15	14 11/16	...
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	...	14½— 14⅝	14½— 14⅝	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	3 %	4 %	...	16 — 17	16½— 17½	17⅜	16⅝
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	12 — 13	12½— 13½	13 3/16	...
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	120 —124	120 —124	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	12 — 13	12 — 13	12⅜	12½
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	14½— 15½	15 — 16	15⅝	15⅜
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9½— 10½	9½ — 10½	10⅛	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	5 %	7 %	9 %	13½— 14½	13½— 14½	14 1/16	13 13/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

‖ Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation April 13th.	Closing Quotation, April 21st.	Business done during week ended April 21st, 1897. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	S	2½%	...	...	⅜ — 1	⅜ — 1	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	1⅛ — 1⅜	1⅛ — 1⅛	...	...
125,000‖	Do. do. 4½ % Perp. Deb. Stock... ...	Stock	4½%	...	...	104 —108	104 —108	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	95 — 99	95 — 99	...	...
9,104	Central London Railway, Ord. Shares	10	...	...	...	9½ — 10	9½ — 10	...	...
207,649	Do. do. do. £6 paid	10	...	...	...	5½ — 6	5½ — 6	...	...
630,000‖	City and South London Railway	Stock	1½%	1⅛%	1⅛%	59 — 61	59 — 61	60½	60
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	1⅜ — 2¼	1⅜ — 2¼	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	...	1⅜ — 2¼	1⅜ — 2¼	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	...	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	4½%	4½%	...	105 —110	106 —110	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	...	1½ — 1⅝	1½ — 1⅝	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2⅜ — 3¼	2⅜ — 3¼	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	⅜ — 1	⅜ — 1	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	¼ — ½	¼ — ½	...	...
9,600‖	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	10½%	...	11 — 13	11 — 13	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	19 — 20	19 — 20	19⅛	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	107 —112	107 —112	...	...
58,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	20½ — 21½	20½ — 21½	20 15/16	...
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	104 —107	104 —107	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	2⅝%	2⅝%	12⅞ — 13	12 13/16 — 12 15/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	16½ — 16⅝	16½ — 16⅝	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	34 — 37	34 — 37	35½	34
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	103 —106	103 —106	...	...
54,000‖	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	10	...	...	...	10⅜ — 11¼	10⅜ — 11¼	10⅜	...

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9⅛.
Electric Construction Corporation, 6 % Debentures, 103—106.
House-to-House Company (£5 paid), 7¼—7⅜.
Do. do. 7 % Preference, of £5, 9¼—9⅜.
Do. do. 4½% Debentures of £100, 108—110.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 11½—12; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Dividend, 1896, on Ordinary Shares 7 %.
London Electric Supply Corporation, £5 Ordinary, 1½—1⅝.
Yorkshire House-to-House Electricity Company. £5 Ordinary Shares fully paid, 8¼—8⅜. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount, 2½ per cent. (April 8th 1897).

THE TRANSMISSION OF POWER TO LONG DISTANCES BY ALTERNATING CURRENTS OF ELECTRICITY.*

By W. B. ESSON, M.Inst.C.E, M.I.E.E., &c.

(*Concluded from page 545.*)

The idle current just referred to has to be supplied whether the motor is running light or loaded, but an addition is made to it as the load is put on. This arises from the fact that the field to which the current in the rotor bars is due, is the resultant of the primary field impressed on the stator, and the cross field produced by the rotor current itself. The rotor currents, and with them the currents in the line, are thus caused to lag behind the impressed E.M.F. with the result that the idle current is largely increased. This does not mean that when loaded the power factor diminishes, for though then the idle current is larger, the proportion of the useful current to the idle current is much greater, the power factor rising in consequence. The power factor depends largely on the size of the motor, and below are figures which may reasonably be expected from motors of different sizes:—

H.P.	Power factor.
1½	·65
4	·70
5	·72
12	·75
15	·78
50	·80
110	·82

These figures accord with the results given by actual tests, and you will be much less likely to be disappointed if you assume them as correct than if you take those given by most makers. They clearly indicate, as I have mentioned before, the necessity for rating the size of generators and transformers at not less than 1 kilowatt per horse-power.

I hope the desirability of getting a power factor as large as possible will be apparent, though I am sorry to say the efforts of designers in this direction have not been always appreciated. In an article which appeared in the *Electrician* last summer, for instance, Prof. Silvanus Thompson regarded it as "a piece of superstition" to demand anything higher for a small ¾ horse-power single phase motor than a power factor of ·49! and went on to say that as the efficiency was 90 per cent., he should not mind if the power factor were smaller. In that article the Professor, inveighing against "the pedantic demand for a high power factor," made the mistake of supposing that he was voicing the opinions of practical men, the very men be it observed who, fully conscious of the advantages which an increased factor would confer, have been most persistently doing their utmost to raise it. This is indeed a very practical question. If the current were in phase with the E.M.F., that is to say, if the power factor were 1 instead of averaging ·75, it would mean that the generators would require to be only three-fourths of the size we have now to make them, that the lines would only require three-fourths of the copper they now have, and that the transformers would only require to have three-fourths of their present capacity. The regulation would require less attention, and the regulating gear would be less costly. Notwithstanding that these advantages would accrue, we are told that the demand for a high power factor is a superstition. Why anyone should hold such an opinion I do not know. Probably it arises from the difference in ideas induced by theorising about power plant on the one hand, and employing it practically on the other.

The lag of the current has not, however, led to much difficulty in working, and it is chiefly on account of the saving in outlay which would result that we should like to see the power factor higher. To some extent the difference in phase between the current and E.M.F. can be compensated by the use of over-excited synchronous motors, these tending to make the current lead instead of lag. A few synchronous motors, taking a fair proportion of the load, make a very perceptible difference to the power factor, and where the circumstances permit, there is rather an advantage in introducing them into the circuits. The Stanley Manufacturing Company, of America, supply with each of their two-phase motors as a usual thing a couple of condensers which supply the idle currents to the motors. One of these is connected in parallel with each of the field circuits, and has a capacity such that the amperes at the working voltage equals the no load current of each field. If there is no distortion of the current wave, the apparent energy taken by the motor is equal to the real energy, and the power factor is therefore very nearly unity. The Stanley Company is the only company manufacturing condensers as part and parcel of power plant equipment, though I believe the idea was rather to enable their motors to run satisfactorily at high frequencies, than to increase the power factor at low ones.

I have now come to the end of my discourse, but with many sins of omission on my head. Though I have been able to deal, in a measure, with the principal factors in transmission of power work, I feel how inadequate have been my efforts to cover so large a field in such a short time. The points to be observed in the construction of transformers for power work I have not been able to touch. Dis-

* Paper read before the Society of Arts on Wednesday, March 24th, 1897. From the Society of Arts *Journal*.

cussion of these would take up a considerable amount of time, as would also the descriptions of switching arrangements in use. Again, there is the question as to whether, for polyphase working, the advantage lies with two-phase or three-phase transmission, a question which cannot be argued at length here. The three-phase system, as we have seen, enables some copper to be saved in lines, but this is practically the sole advantage, and it must be remembered that only when the distance exceeds 25 miles, does the saving in copper over the two-phase system figure up to anything like 5 per cent. on the total cost of the scheme. Considering the simplicity of the two-phase system, and the ease with which it can be worked, as compared with three-phase, especially where lighting is combined with power, it seems that the saving in copper is so small a fraction of the whole cost as not to be worth considering. The difficulty due to uneven loading of the circuits in three-phase working is particularly objectionable, and it must be remembered that not only have the currents to be balanced in the three branches but the kind of load must be similar; it will not do to have an inductive load on one branch and non-inductive loads on the others. To get over this difficulty in a general system of distribution by three-phases a fourth conductor has to be used as a balancing wire or common return, so that in the end as many conductors are required as for the two-phase system. For the transmission of power only in large units the three-phase system is all right, but where lighting is combined with power two-phase is always preferable. In the latter the circuits are not electrically interlinked in the generator armatures, and as a consequence the regulation of the E.M.F. on the lines is much more satisfactory, and can be carried out without expensive and complicated gear. In fact the two-phase system, with all the simplicity and ease of control of single-phase, possesses all the important advantages of three-phases.

Discussion.

Mr. A. T. Snell regretted that, not having had the opportunity of seeing the paper in print, he was not in a position to discuss it, interesting as it was. The author seemed to have taken up the subject at the point where Mr. Kapp left it, and to have brought it down to the present time, and though he had had to omit much, he had referred to the most salient points in connection with generators, line, and motors. On the latter branch of the subject he believed several experiments had recently been made on polyphase and single-phase motors, and he hoped someone would be able to state the results.

Mr. W. M. Mordey said he was sorry not to be able to speak from experience with regard to polyphase motors. There was a great difficulty in discussing papers of this kind, resembling the multiplication table in absolute truth. He was glad Mr. Esson had alluded to the vexed question of a standard frequency, and he wished some arrangement could be made by which a standard could be fixed. It was impossible to decide on an absolutely best frequency, as there was no such thing for all purposes, but they might decide on one which would be best for all electrical engineers, simply because it would be standard. Then Mr. Esson referred to the question of sine, as against saw-toothed curves, and seemed to express a preference for the latter under some conditions. It was said that Nature abhorred a vacuum, and he believed Nature abhorred saw-toothed curves, and that it did not much matter what they made the curve, because Nature would take care of it afterwards. He drew attention to the fact that nearly all published experiments on the forms of curves had been made at electrical colleges, on machines running light; few or none were made under the working conditions which obtained on distribution systems. A curve might be saw-shaped to begin with, but when you considered everything that took place in the way of self-induction, in the fact that machines were running in parallel, that there were motors, arc lamps on the circuits, and so on, he believed that it would usually be found very little of the form of the original curve would be left. He would recommend gentlemen who had experimental facilities, and were fond of experimenting on the shape of waves, to try and induce some central station engineers to let them experiment in the first place on the form of wave with a light running machine, no load and no other machine running parallel, and then on the circuits supplied by the same machines under full load conditions, particularly if they could do this on a system where there were motors on the circuit. He agreed as to the desirability of getting alternators to give a good "characteristic," but he could not agree with the author's remark that for power work, where a good regulating machine was required, single wound field magnets were not as much used as separate magnets. He believed that on the Continent, where far more power was used than here, single wound magnets were used, and it was a mistake to suppose they were not as good regulators as machines wound with separate magnets. He thought the contrary was the case. He would like to show the author such a machine, which had a drop of not more than one-fourth that mentioned in the paper. With regard to insulators, he might mention a plan which he had found very useful for testing the insulation of porcelain, so that imperfect insulators might be weeded out before use. The insulators should be turned upside down in a tray of water, and the cups filled with water, and in each should be hung a little bit of copper wire connected with one terminal of a dynamo, the other terminal being joined to the tray. After running a few hours the water in the faulty insulators would be, more or less, coloured blue, according to the amount of leakage through the insulator, which caused a formation of copper salt. Those which showed no colouration could be safely used.

The Chairman said the subject of alternating current motors really deserved much more discussion than gentlemen present seemed disposed to give it. It was, in his opinion, still an open question whether the continuous current motor had been absolutely displaced, whether the great move in favour of alternating current was going to last, and whether Mr. Kapp's declaration that alternate current working would form the ultimate solution of the problem how to transmit power over great distances was correct. Perhaps it was hardly appropriate to the paper to say anything about continuous current motors, but he wanted, at least, to utter a warning that it must not yet be accepted as an axiom that the transmission of power to a distance was impossible with continuous currents. He was rather disappointed that Mr. Esson had not described the monocycle motor, which was said to be an ingenious combination of the single-phase and three-phase system. There were indications in the paper that the transmission of power by alternating currents was not altogether so easy and straightforward as some might think. It was stated, for instance, that the conditions under which they had to work were extremely trying. You had to make rather a complicated arrangement of coils in the machine, and to use three or four wires, and step-up and step-down transformers, all of which were not very conducive to smooth working in practice. What decided the success of a system was the ease with which it could be worked. Most great inventions commenced by being very complicated, and were gradually simplified until you almost wondered why the complicated thing was invented first. When, therefore, he met with any system which was complicated, he distrusted it, and thought it could not be right. Another difficulty to which Mr. Esson called attention was the power-factor, which averaged ·75, instead of unity, as in the case of the continuous current. If the power factor could be increased to unity, generators would only require to be three-quarter the size, and lines would only take three-fourths the copper; but even then there would be the transformers which, in the continuous current, were not required. All this indicated that alternating current motors had not got it all their own way, and, in his view, the simplicity of the continuous current indicated that it would yet prove to be the right solution of the problem. However, without any further criticism of the system, he would propose a hearty vote of thanks to Mr. Esson for the very able and thorough manner in which he had brought the subject before them.

Mr. A. W. Marshall said he gathered from the paper that the speed of the motor decreased when the load came on; but he did not understand whether there was any means of regulating or altering the speed if desired.

The vote of thanks having been carried,

Mr. Esson, in reply, said he had written a description of the monocyclic system, but had to strike it out, owing to the paper being too long already. It was really a most interesting system, but he feared it would not come into general use in this country. With regard to continuous current *versus* alternating current motors, they all knew that the chairman was in favour of the former, for what reason he knew not; but the fact was that large powers had been transmitted to long distances by alternating currents, and as yet it had not been accomplished with continuous currents. All Mr. Siemens had to do was to show how it could be done; he would not say it could not be done, but it had not been done yet. The continuous current plants used were for comparatively small powers and short distances. It was, perhaps, unfortunate that there was a power-factor to be considered, but still it had not prevented the system being a success. He concluded by inviting those interested to inspect two very interesting motors kindly lent him by Messrs. Langdon Davis & Co., and the Motor Company, Limited; one a non-synchronous, self-starting motor, the other a synchronous, self-starting motor, each suitable for working with a single-phase lighting system.

The Chairman said his firm had executed some of the largest power transmission works with three-phase and two-phase currents, so that he knew something about them; but he was still of the deliberate opinion that the continuous current was the best.

Mr. Graham Harris said he had been engaged in very many cases of transmission of power by the alternating current, but after a good deal of consideration extending over some years, he was inclined to agree with the chairman that the alternating current had not as yet proved its superiority.

THE "WALKER SYSTEM" OF ELECTRIC TRACTION.*

By JUSTUS ECK, M.A. (Cantab).

In introducing the "Walker system" of electric traction to your notice, I first wish to draw attention to the scope of the paper. There is no intention at the present time of dealing with the intimate technicalities of the electric traction question that would come before such a Society as the Institution of Electrical Engineers, but to point out to you the various specialities and advantages of this system, so far as they concern the tramway owner, manager or engineer.

To explain the origin of the word "Walker system," I should like to remind you that as early as 1883 a very powerful organisation, called the Walker Manufacturing Company, was organised in Cleveland, Ohio, as a general engineering firm, and which gave special attention to cable tramways for street work, and which, after carrying on the various departments of this work for 10 years, became convinced that electricity would be the probable motive power for most power traction lines in the future, as it presented the great advantages of easier extension and addition to existing power lines, a low cost of operation, and the possibility of working over large areas with a moderate capital outlay.

Entering so late in the field was no detriment to the Walker Company, who conceived the idea that electric generators and motors are

* Paper read before the Tramways Institute, April, 1897.

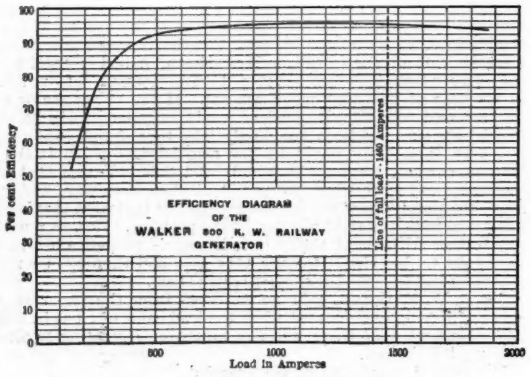
after all only pieces of machinery, and require but high class workmanship and material to make them as reliable as steam engines or water-wheels.

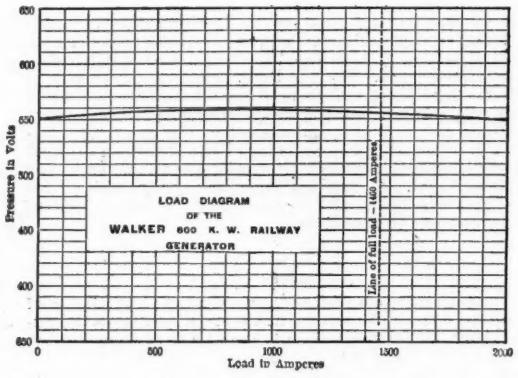
Previous to the time of their entering into the manufacture, there was an impression that all electrical machinery was somewhat mysterious and unreliable in working; but they decided not to be influenced by this impression. The striking and immediate success of the application of their electrical manufactures convinced them and everybody else of the soundness of this policy. The Walker Company apply the same skill to their work as Messrs. Browne and Sharpe do to their well-known tools, with equally satisfactory results.

The essential points of the Walker system consist of the application of extensive street railway experience to the perfection of many small details with a net result that the road apparatus is so simple,

Engines and boilers of various efficiency and having many points to recommend them, may be bought from a large number of well-known engineering firms in this country and elsewhere. Any modern engine that is capable of delivering its power with a fairly regular speed, provided it has good fly-wheel power, is suitable for driving a Walker railway generator. The Walker Company are also makers of specially suitable engines for this work.

The Walker railway generator is the fount of the electric power, and in designing it great care has been taken to eliminate the mistake of starving it of either iron or copper; the want of either of these materials decreases the efficiency and also the life of a dynamo with the further disadvantage, viz., that when any emergency or extra demand is put upon the generator, it is apt to fail at the very time when greatest trouble is the result.





that no skilled man is required as driver, and the station apparatus is so reliable, that a service free from breakdowns is secured to the travelling public and a remunerative investment to the purchaser.

Messrs. Laing, Wharton & Down, electric traction engineers of London, the British representatives, are adding to the value of the system by modifications to suit the requirements of the British tramway engineer.

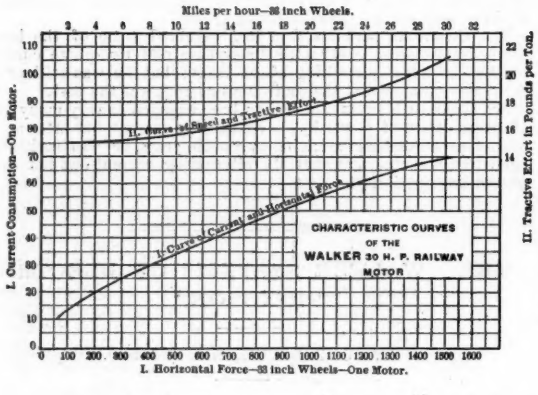
They, also, when starting in this line of business carefully considered the question of patents and decided in this matter as follows:—

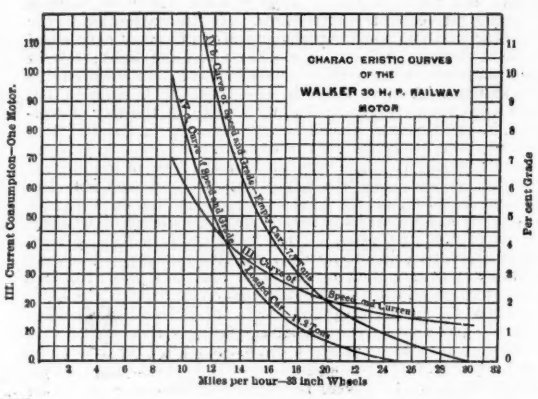
That as the principles and details of dynamo and motor construction had been well understood by scientific men and manufacturers

In America, where heavy snow storms are frequent, it sometimes happens even in a well-designed generating station that the load on the generators has been for several hours fully 100 per cent. above the normal output for which they were constructed, and it is under these circumstances that the maker who puts extra material into his generator, and the user who buys it, realise the value of the extra cost.

The generators are made of several sizes, with varying numbers of pole-pieces, and embrace a range of power from 100 kilowatts to 1,600 kilowatts (or to put it in horse-power, from 135 to 2,150) with speeds going down as low as 75 revolutions per minute.

Every dynamo has a certain number of pole-pieces, and in the case of the Walker railway generator the number varies from 4 to 14.


Miles per hour—33 inch Wheels.
I. Current Consumption—One Motor.
II. Curves of Speed and Tractive Effort
I. Curves of Current and Horizontal Force
CHARACTERISTIC CURVES
OF THE
WALKER 30 H. P. RAILWAY
MOTOR
II. Tractive Effort in Pounds per Ton.
I. Horizontal Force—33 inch Wheels—One Motor.



for nearly fifty years, there were no valid patents which prevent *any one* from constructing such machinery substantially in any form desired, but still they decided to have a respect for all valid patents, and also have no intention whatever of going behind the *moral* right of any inventor to his invention. Whilst adopting this honourable position they have at the same time every intention of rigidly protecting their own patent rights which cover various details of the manufacture, &c., of their machines.

Before going directly to the subject of the machinery it will be well to draw your attention to the fact that the factory where it is made now covers over 10 acres of ground, and contains tools of very large size capable of dealing with dynamo and other machines weighing up to 170,000 pounds per piece, and also that during the last few months two additional sites have been purchased and are being rapidly equipped for the enlargement of the works to meet current demands.

During this short period of three years, 22 types of generators and six types of railway motors have been successfully designed and manufactured in quantity to standard patterns.

Each of these pole-pieces consists of a number of plates of iron notched at one end. These are built up side by side with two stout outside plates, and then held radially in clamping frames with the dovetails outwards at their proper angular distribution; they are then put in the mould, and an iron yoke cast round them. Iron is preferred, as it secures better regulation and the necessary cross section required for magnetic purposes ensures at the same time a greater rigidity in the machinery, coupled with less cost.

The surface contact between the dovetail and the yoke is at least twice the cross section of the latter, so as to secure an even and economic field.

Half rings, with pole-pieces projecting inwards, are thus obtained. Two of these, when bolted together, form the ring of magnetic poles in which the armature rotates.

Each pole-piece is sawn nearly in half from the centre; the object of this is to secure greater rigidity to the magnetic field, thereby minimising the change of position of the brushes with varying loads, on the pole-piece is a band of steel, the pole shoe which retains in its place the field spool.

The field spools are most carefully made, and are insulated with mica and millboard, and wound as follows:—The shunt winding by the side of, and separated from, the series winding by a layer of mica and millboard. The shunt coils are wound in the usual way with wire, but the series coils consist of thin copper tapes, so thin that there is only one turn for each layer, the number of layers and size of tape being in proportion to the amperes and output of the machines. As the tape of copper winds on, adhesive insulating tape is also laid between each layer.

The tops of the windings are protected by prepared cloth and finally by neat rope winding.

To the ring of field magnets at four of the neutral points is attached a ring of somewhat smaller size which carries the brush rocker and brush-holders, there being one brush to each pole.

One object of this arrangement which is used on all direct coupled generators is to enable the outer bearing to be removed without interfering with the brush-holders, and another is that the adjusting worm screw, which traverses the brushes either forwards or backwards, works upon a very large circumference so that greater accuracy of adjustment is obtained.

Trial has proved these generators to be sparkless at the commutators *without shifting the brushes* up to 50 per cent. and even 75 per cent. over load.

The armature consists of a solid forged steel shaft on which is mounted a cast spider; the object of the radial cutting is to free it from strains, and to this is attached, by means of dovetails, the disc-segments. These disc-segments over-lap, and when a sufficient number of them are in place they are firmly bolted together between heavy cast-iron end discs, thus making a rigid core for the armature coils. Each slot is carefully tooled out, and special insulation is laid into it in the following order.

First of all, a millboard trough is made, then a trough of oiled linen, then one of mica, then one of oiled paper, and then one of millboard again.

Into this the conductors are laid, and a hard wooden strip is put on the top, the various layers being separated by a strip of composite insulation. Finally the millboard, mica, and other insulating substances, are closed over, and the whole securely bound in by means of wire laid into grooves turned in the disc segments, thus securing minimum air gap. Lap winding and wave winding is employed. Ventilation is secured by ½-inch distance pieces between groups of armature segments.

Armature Building (Segment Exposed).

All the coils are machine formed, so that they are easily laid in place and brought down to the commutator segments, where they are securely soldered. They consist of copper tape tinned, for convenience in soldering, and are waterproof.

The back ends of the armatures have a very neat appearance, so that it seems almost a pity to enclose it in the canvas binding, which, however, is a necessity, to keep out dirt and grease.

The back and front ends are further protected by a brass ring, so that it is perfectly safe to handle the biggest armatures in spite of their great weight.

The commutator consists of a spider wheel overlaid with insulating strips, on which are placed drop-forged copper segments held down with insulating material under end caps, and the whole then bolted together, thus making an extremely simple, and at the same time a very reliable form of commutator, from which many of the complaints usually found in such delicate parts of a generator are eliminated. All the segments are of drop forged pure copper, so that the commutators are free from soft places and holes. The commutator is keyed to the armature spider, so that both can be removed together from the shaft, which is a step in advance of most makes.

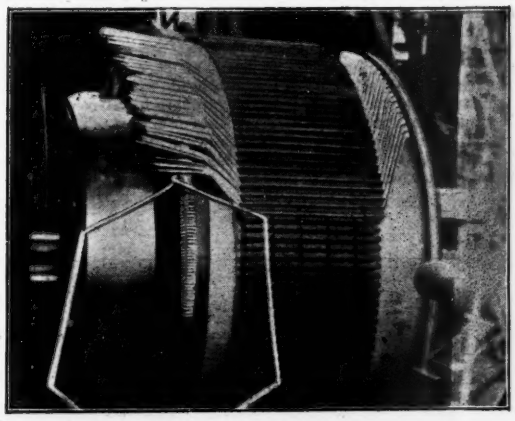
The armature is mounted in the usual way in first quality self-aligning bearings, and supplied with all the necessary lubricating apparatus, which in standard patterns consist of two oil rings in an oil well, a gauge glass shows the height of the oil in this well. The bearings are of such ample size, that reliable lubrication is secured this way.

In most of the large machines arrangements are made for allowing the field magnets to slide axially, so that the armature may be examined at any time without taking these heavy parts to pieces.

The generators are made usually for generating at 550 volts, sometimes up to 800 volts; but arrangements are made in the wave windings so that by changing the commutator, and altering the connections, a lower voltage for cell charging and other purposes can be obtained without deviating from standard patterns.

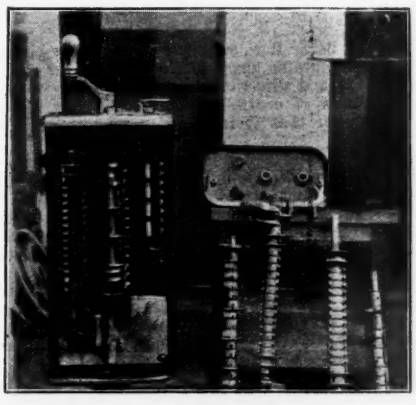
The generators are belt or rope driven, or direct coupled to engines, according to size and requirements.

The current from the generators passes to the Walker switchboard, which is built in sections, there being as many generator sections as there are generators, and also a Board of Trade section, having on it the special instruments required by the Board of Trade, and also the various feeder panels for supplying the feeder circuits to outlying parts of the tramway system.



Generator Armature Winding.

These switchboards are made either of slate or marble, and have an arrangement of angle iron pieces running vertically, by means of which the switchboard is easily added to when "extensions" of the tramway system takes place. This construction also secured that desirable result, namely, a fireproof switchboard, which is also a handsome addition to the generating station.



Complete Controller.

To secure absolute perpendicularity of the board, a long turn buckle is provided in place of the upper end stay, so that this desirable feature is quickly obtained. The angle iron pieces mentioned before form very convenient supports for carrying up heavy cables from large generators to the switchboard, and the whole is so arranged that when the switchboard is completed, it is almost as neat at the back as in the front.

The generator panel usually consists of two main switches connecting the positive pole of the generator to the line bus (or main) bar, and the negative pole to the earth bar.

The positive wire passes on through the amperemeter which measure the current output, and then through an automatic circuit-breaker, which protects the generator from excessive currents.

Switches are also provided for the field circuits, and for regulating the resistance in the shunt field.

The feeder panel usually has two feeder circuits to it, each provided

with a circuit breaker and an ammeter for indicating the current passing out to that section, also a main switch for isolating the circuits.

The standard size of the panels is 90 inches in height and 24 inches in width for all sizes up to 3,000 amperes for the generators and 1,500 for the circuits.

The resistance switches are carried on the front of the panel, but the resistance coils themselves are carried on the back, allowing them to be easily examined, and at the same time carrying any heat generated in them away from the measuring instruments.

The current from the switchboard passes by underground or overhead feeder wires to the tramway line, and then should this be of the overhead construction it is collected by the Walker trolley, which differs from the ordinary V-wheel trolley, in that it consists of a roller mounted at the end of the pole. This eliminates all trouble with turn-outs and crossings, and prevents the breakage of span wire which often occurs when such is used, thus materially lowering the expenses of up-keep. This roller is mounted on ball bearings, and requires no oiling even up to 30 miles per hour or 5,000 revolutions per minute. A copper brush inside provides a low resistance path for the current and the pressure against the trolley line is always ample to secure rotation of the roller.

The Walker trolley has also the advantage of collecting the current with perfect certainty, and it also enables the car to be run at full speed when changing from one line to another, it being almost independent of the setting of the overhead wire. When using the ordinary trolley, a great amount of care has to be exercised in keeping it to the line when passing points or curves. The trolley pole retains a fixed position as regards the vertical longitudinal plane of the car when working, but when hauled down can be reversed for running backwards.

Controller showing Special Gearing.

The current being thus collected passes through the two main switches and a lightning guard to the Walker controller, which regulates the speed and direction in which the motor runs. There are one or two forms of controllers in use, but it is claimed for the Walker controller that it is superior to these in the following points:—

When the controller is turning the current off from the motors there is always considerable difficulty in obviating dangerous sparks, and in some cases a magnetic blow-out arrangement has been used to obtain this effect. These, however, at all times require current in them so that there is a constant waste at this point; and further than this, unless there is a large current in the blow-out coils the spark breaking power is extremely small.

The method employed in the Walker controller is sub-dividing the breaking spark between 32 contacts in series so that the sparking effect obtained between each of these contacts is very small, it being $\frac{1}{32}$nd of the total amount of each point. At the same time the inductive spark from the blow-out coil is saved.

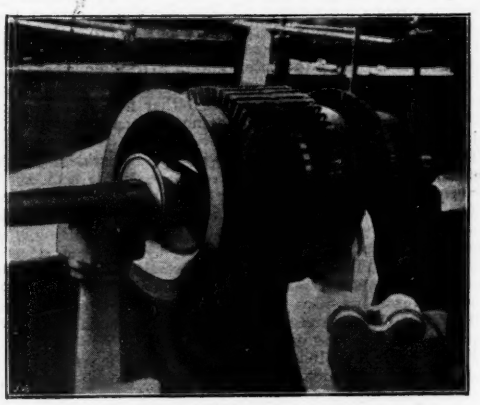
Another particular point is that directly the controller handle is turned back to reduce speed the current is immediately shut off the motor, so that it is possible for the motor man to immediately put on his brakes without any harm happening to the motors.

The controller, which is of the series parallel type, is both fire and waterproof and occupies a minimum of space. It has two handles, one for controlling the speed and the other the direction, and these are so interlocked that unless the direction handle is fully over either "forward" or "back," the speed regulating handle will not move. In addition to this, it is so arranged that unless the spark breaking cylinder is so placed that the circuit is broken it is impossible to move the direction handle.

To eliminate any resistance effect of the spark breaking contacts an arrangement is made so that the whole of these are cut out of circuit when the controller handle is moved forward.

In order to promote the long life of the controller, and as the spark cylinders are apt to wear when going on one face, these cylinders are so made that they may be inverted, and double wear obtained by using the other face. The exact electrical details, however, will be probably far more interesting to the electrician than to the tramway manager. Another noticeable point is the absence of the usual vulcabeston fences and bridges, thus allowing the controller to be kept clean, and under easy inspection. The swinging of the cover is also an improvement, permitting of very easy access. Switches are provided for cutting out either motor should it be disabled.

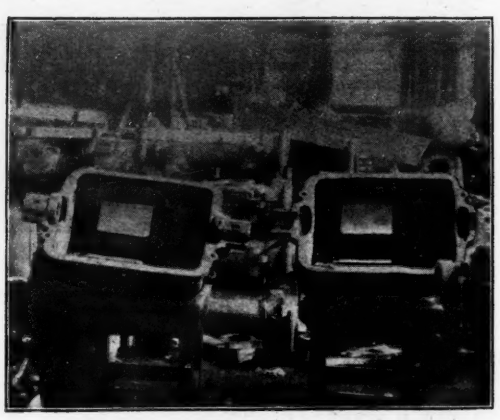
The motors are of similar construction to the dynamos, so far as the armatures are concerned, the exception being that the armature discs are in entire rings, instead of as in the generator discs, they being each stamped out of the plate at a single blow. The coils are soaked several times in asphaltum, and so made entirely waterproof, and also subjected to a 5,000-volt pressure test before use.



Motor Armature before Winding.

The field magnets, however, differ very considerably from those of the generators, although the winding is carried out on the same principle.

The field magnets are of soft cast-steel, and form a complete box when closed together, and the field coils, which are waterproofed, are held in place on the four poles that are inside, by brass clips held by a set screw. This box, formed by the field magnets, is so arranged as to open either upwards or downwards, thereby providing for inspection from the top, through the floor of the car body, or from below in the car pit. The armature is held in place firmly during either of these operations, and can also be taken out above or below. The bearings are outside the magnet case, and are easily detached.



Motor Box showing Fields in Place.

The armature windings are so arranged that there are only two brushes, and these are 90° apart, and are built in such a manner that the brushes can be easily placed under the trap, as shown in the drawing. Oil rings are provided outside the magnet case, so that all oil drippings, &c., are prevented from running into the armature. The commutator has very high insulation, it being entirely of mica, with 2 inches of surface between the live parts and the frame. It has also a very long life.

The whole, when closed up, is practically dust-proof, the spur wheel and pinion running in a case containing oil, and vibration and jar from this is unnoticeable. Gears have run over 1,000,000 miles. One great speciality of the Walker motor is its method of suspension, and the value of this will readily appeal to anyone who has studied the subject of rail depreciation on power traction lines.

The principle of suspension is that the motor is hung upon springs both in front and behind, so that should the car, when in motion, meet with an obstruction or a raised point, it does not strike the rail with a hammer blow equal to the weight of motor added to that of the wheels, but with a blow in which a spring is inserted, which means a very different life to the permanent way and electric bonds.

This same spring also comes into effect when the motor is started to work, and no unpleasant jolting from rapid application of power

is observed, the springs first having to become compressed before the motor can exert its full power from the pinion.

The rear end of the motor is hung in the well-known way for most electrical motors for this class of work, and has also a spring. Too great value cannot be placed on the suspension of motors, as the even riding of these affects, first of all, the track, with its many points and expensive crossings; next, the electrical bonding of the rails, causing the spring rest of bonds to become brittle, then the spur wheel and pinion, also the armature wires, which must in course of time feel the effect of constant jolting; and, finally, most important of all, the comfortable riding of the passengers.

Realising the great importance of having the motors as nearly perfect as possible, greatest care has been taken in designing them to embody every improvement suggested by actual use that comes to the notice of the company, and, as a result of this, the following points come strongly to the front in the Walker motor.

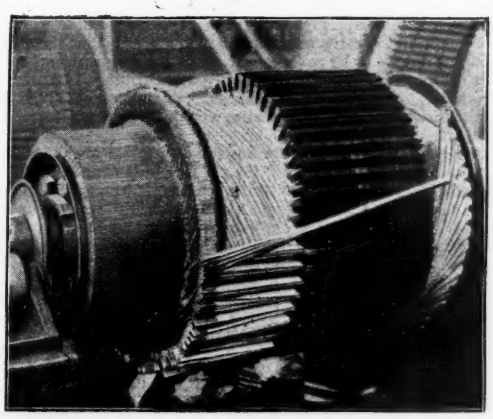
It is extremely accessible from the top and from underneath, whilst retaining all the advantages of being free from dust, water, or oil inside. All the parts are interchangeable, and all bolts in the main body are of the same size, and drop in from the top, and have locked nuts and spring cotters. The weight is reduced to a minimum for the strength and freedom from breakdown that is essential.

All motors are tested under 5,000 volts pressure before passing out of the shops, and the unstinted use of mica, gives an insulation that keeps the armature free from the burn-outs not at all unknown on some systems.

Every motor is carefully tested for power before leaving the works in the following manner. It is set to run on a Prony brake till the full rated power is obtained for one hour continuously at the pinion and at the end of this time if the temperature rise is under 150 degrees Fahrenheit it is passed.

Rating motors in this way has been found to keep them within safe heating limits in the hottest of American summer weather with the heaviest loads for which they are constructed.

All the motors for railway work are what is known as single reduction type, which means that the power from the armature spindle is transmitted through a pinion on it to a spur-wheel keyed to the



Motor Armature Showing Winding.

wheel axle, this permits of hanging the motors on the Walker spring suspension principle and also allows them to run at moderately high speeds thus securing a reduction in weight. There are other incidental advantages in this spur gearing.

The gearing is enclosed in a malleable iron housing which keeps it free from dust and dirt and also acts as an oil well into which the larger spur wheel dips and gathers oil making the friction in the gear low and the noise of it inappreciable. The pinions are usually of steel with malleable iron wheels on the axles.

In dealing with the apparatus so far nothing has been said of efficiency. The mechanical friction is, as must be evident from the design, extremely low. The electrical efficiency is equally good.

The diagram shows the efficiency of a Walker generator at from practically no load to 30 per cent. overload, and it will be noticed that the efficiency is practically constant from 30 per cent. load to 30 per cent. overload, and of an average of 93 per cent. and rising to over 96 per cent.

The other diagram shows the excellent compounding of this same dynamo.

The characteristic curves of the motors are also interesting, and show that in the design working conditions have been considered. When starting railway motors, they take at first the maximum current; this, however, soon drops to half and less, and during a portion of the time of running the motor is receiving no current.

It is therefore important that the motor should have good efficiency at overload as well as at light load, also in many cases gradients require long application of medium power. It will be seen from the diagrams that the Walker motors comply with these requirements, the efficiency rising rapidly up to one-quarter load, and then to a maximum at one-third load, to continue about the same to 25 to 35 per cent. overload.

The motors are made in six sizes as under:—

No.	H.P.	Lbs. pull.	Miles per hour.
3	25	800	20
4	30	1,000	30
5	35	1,200	35
10	50	2,000	40
15	75	3,000	50
20	125	5,000	50

The pull is reckoned at 10 miles per hour in all cases, and with 33-inch wheels.

To further prove the efficiency of the motors, the Walker motors No. 3 size have 144 turns of magnet wire against 191 of one of the large opposition makers. To secure the extra space for this larger number of turns, the cross-section of the wire is 25 per cent. less, thus adding further resistance to the circuit. The same applies to the winding of the equivalent motor to our No. 10 size, except the discrepancy in cross section is still greater.

The Walker Company do not interest themselves particularly in the construction of car bodies or trucks or wheels, preferring to leave those parts to firms who make a speciality of such articles.

As they construct their motors to standard designs, there is no difficulty of attaching these parts to the parts constructed by other firms.

MULTIPHASE INDUCTION MOTORS.

By A. C. Eborall, A.I.E.E.

(*Continued from page 507.*)

There is yet another way of starting multiphase induction motors, and one that is quite extensively used, more especially by the Oerlikon Company, of Zürich. It is shown in fig. 25, and consists, as will be

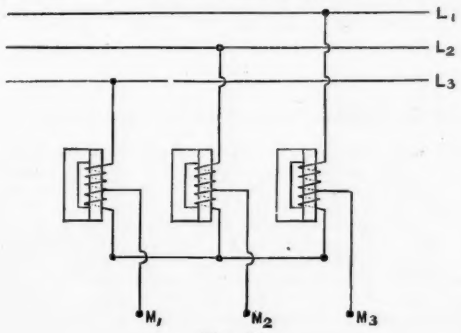


Fig. 25.

seen, of a step-down transformer of simple construction, the motor being connected to the part of few windings and the line to that of many. The result of this is that the motor takes a large low

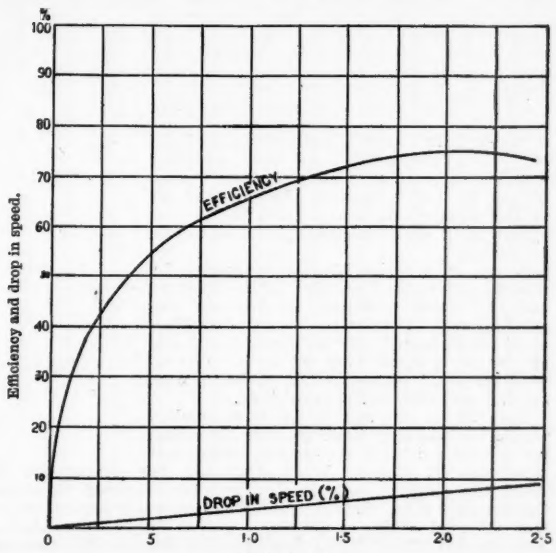


Fig. 26.

voltage current, the line supplying a smaller current at considerably greater pressure. After the motor has run up to a speed near the normal, the transformers are cut out and the motor switched direct on the line. This method of starting is of course equally applicable to a two-phase motor, when two transformers only would be required

By the employment of such a device, the necessity for a wound rotor with slip rings disappears, and the simple short-circuited winding (or developments of it) can be used, even in quite large motors. But apart from this advantage, it is distinctly inferior to the non-inductive resistance in the rotor, because the output of an induction motor is practically proportional to the square of the impressed pressure, and hence reducing this pressure for starting purposes must result in a very small starting torque, and as a matter of fact,

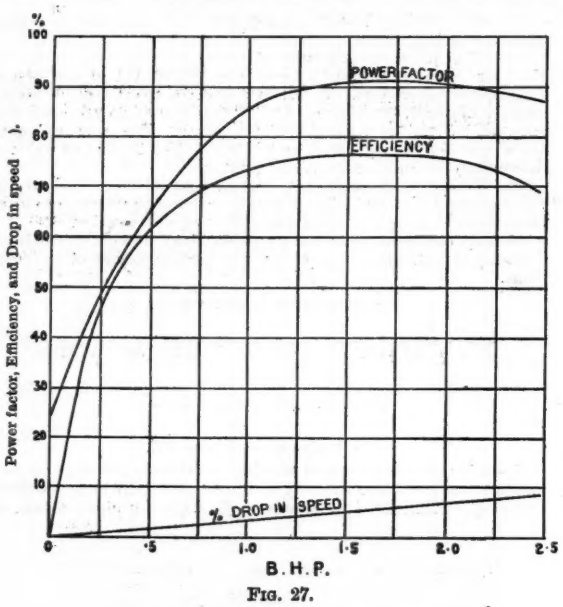


FIG. 27.

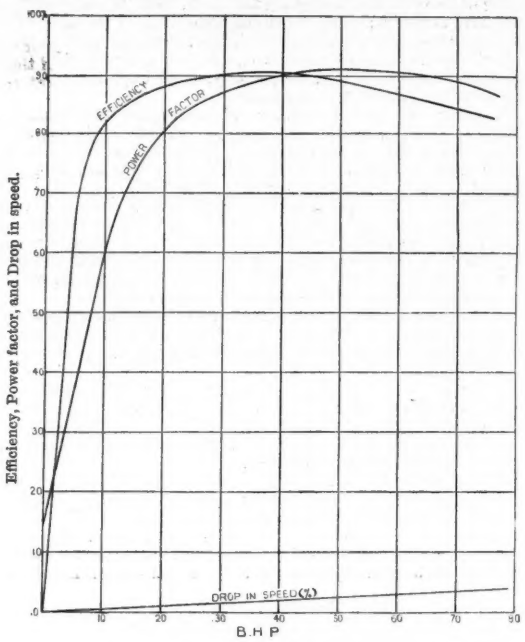


FIG. 28.

motors using this starting arrangement must always start on a loose pulley.

From what has been said above, it is clear that the insertion of a resistance in the *stator* at starting must also result in a small torque for the same reason, and hence this is rarely if ever done in practice.

It may be remarked here that the fact of the output of an induction motor being very approximately proportional to the square of the impressed pressure, makes it essential that the regulation of any motor circuit should be fairly good, because if the tension on the lines should suddenly decrease from any cause, such as might be produced by starting up a large motor too quickly, or without its resistance, any heavily loaded motors on the circuits at the time may pull up, for a motor that would carry a large over-load at its normal tension, would barely take its full load with a reduction of 25 per cent. in the line pressure. This is, however, the only way in which the pressure on the stator affects the speed regulation of an induction motor.

The "auto-transformer" device shown in fig. 25 is in practice considerably elaborated for large motors, the tension being gradually increased (by varying the windings on the transformer) as the motor runs up, the final result being that the windings are either short-circuited or cut out.

For moderate starting torques it is probable that a starting resistance in the motor, combined with an "auto-transformer" on the stator, would disturb the circuit least, and be effective; but in the light of modern practice, it does not appear as if such elaborate precautions were necessary.

Several other devices have been suggested for starting motors, but the author believes that the first two above mentioned are the only ones generally used. For instance, the stator windings could be connected star fashion to start, and afterwards changed over to mesh. Or the windings could be arranged in series to start, and then switched over to parallel, &c.

The effect of resistance in the short-circuited part of an induction motor supplies the reason for several points of construction that might otherwise not appear. When describing the construction of rotors with simple short-circuited bar winding, the author mentioned that the rings at the ends are made of considerably smaller section than the total section of the bars. This is simply to enable the motor to start effectively, the resistance of the copper rings with such large currents as they would carry at starting being quite sufficient to enable this to be done. It does not matter much about the current density in the rings being high with the motor working, as, owing to the excellent cooling, the heat can readily get away. Again, in designing rotors for induction motors, it is customary to allow a considerably greater current density in the rotor conductors than in those of the stator, because, apart from the better ventilation, the iron losses in the rotor are very small indeed, owing to the extremely low frequency of the rotor currents, and hence the copper losses may be made greater in proportion to those in the stator.

There is, however, another factor entering into the case. At any given load on a motor, the torque is proportional to the product of the induction in the air gap, and the current in the rotor conductors, and therefore the rotor must run at such a speed that the slip allows enough pressure to be generated in the rotor to overcome the resistance of its conductors. This is only when leakage is absent, which it never is, and hence on this account, and also because of the pressure drop on the stator, the slip would be somewhat greater than this.

It therefore follows that for a given torque the slip is nearly proportional to the resistance of the rotor, and hence that the effect of giving a certain amount of resistance to the rings, and of working with high current densities is to cause a corresponding drop in speed of the motor, and must not be carried too far. To make a motor synchronous, all that has to be done is to put a lot of copper in the rotor, and what is done in practice is to use comparatively few rotor conductors, and work with a low current density. Such induction motors start unwillingly and take a large current, their no load current also being high, perhaps 50—60 per cent. of the full load current. Also, they will carry comparatively little overload—25 per cent. above the normal is generally sufficient to make them run out of step. Such multiphase motors are rarely asked for—their only application would seem to be for driving rectifiers—as the speed regulation of the ordinary rotary field motor is amply good enough for commercial work.

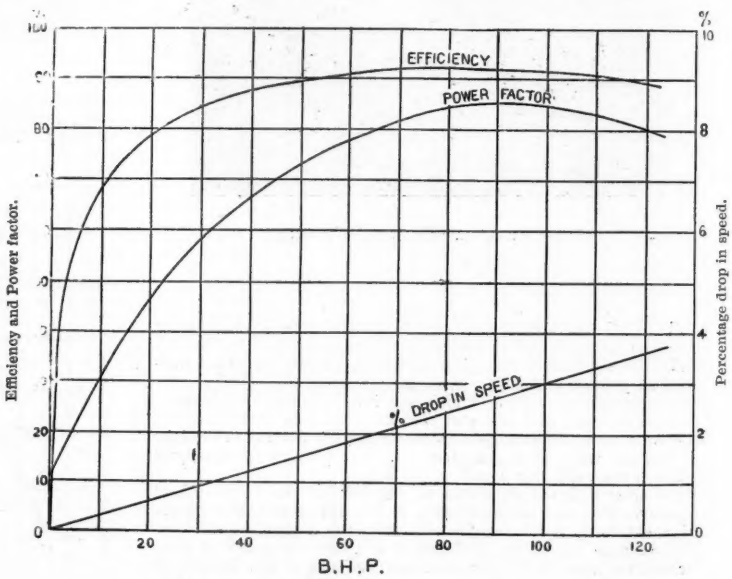


FIG. 29.

In motors to be used for crane and hoist work, the employment of starting resistances in order to obtain the large torques required is, on the whole, not advisable—the requirements being as a rule that the motor shall be capable of being directly switched in, without any manipulation. Multiphase motors for this purpose are specially designed for a large slip—for instance, the rotor would rarely be of the simple bar form—in general it would be wound in sections, across chords, these sections being separately short circuited, and the breadth of a section depending on the number of poles and holes in the stator. Such motors would have a considerable rotor resistance, and hence large drop in speed, which does not matter. Their power factor would also be low, owing to the character of the winding.

The author would now like to draw attention to the curves shown in figs. 26, 27, 28 and 29, which are typical of the performance of induction motors of to-day.

Fig. 26 shows tests made on a 2-H.P. two-phase Brown motor working at 40 ~, and fig. 27 tests made on an American three-phase motor of 2 H.P. and designed for 50 ~.

Figs. 28 and 29 give the efficiency, power factor, and regulation for a 50-H P. two-phase motor built by the Westinghouse Company, and for a 100-H.P. three-phase Oerlikon motor. The former was designed for 25 ~, and the latter for 50 ~.

In the case of the small motors it will be seen that the efficiency and power factor attain high values from half load up, with but slight variation over their working range. The speed regulation in both is also very good.

In the larger motors the efficiency curve goes up very sharply, and is about 90 per cent. over a long range of working. The power factor is also high above three-quarter load, and the drop in speed, even on over-load, quite small.

(*To be continued.*)

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

Some Recent Developments in Electric Traction Appliances.

By A. K. Baylor. Read April 8th, 1897.

(*Continued from page* 527.)

Here is a composite board of generator and feeder panels, and the general arrangement of instruments followed in practice. This board also includes a "station" or "total current" panel fitted with high reading ammeter and wattmeter. The lightning arresters and field rheostats are mounted at the back of the generator panels.

It is usual on any extended system of electric traction to divide the line into insulated sections fed by separate feeders. Where it is practicable, the separate feeders are carried back from each individual section to the station, so that any part of the line may be thrown in or out of circuit at the main switchboard.

As a rule, automatic circuit breakers are placed in the feeder circuits as well as on the station mains, thus doubly protecting the generators. In early practice a fusible cut-out was thought sufficient to protect the dynamo from any excessive drafts of current, but it was found that a fuse small enough to properly protect the machine was subject to such frequent replacement as to prove an inconvenience. Automatic circuit breakers were then adopted, mounted upon the switchboard of each generator; separate feeder circuits, when they were used, being fitted with fuses. This arrangement is sometimes followed still, but the free use of automatic circuit-breakers in central stations is becoming more and more universal, and now, as a rule, they are placed on all the separate feeder circuits as well as the station mains.

Overhead Line.

As a means of conveying current to the car, the overhead trolley system must still be considered the standard, and where maximum efficiency is to be combined with minimum cost for installation, there is little probability of its being superseded. Aside from the objection that may be raised to overhead trolley construction on the score of appearance, everything is in its favour, and there is no doubt that most of the prejudice against it is based on ignorance as to the character of a well-constructed line. There are certain districts, of course, where an overhead trolley wire could never be sanctioned, but for general purposes it has much to recommend it. Its general popularity in America has come gradually. The idea that overhead wires can be erected promiscuously in American cities is distinctly erroneous, and the opposition met with when the first trolley systems were installed there was, in every way, as vigorous as it has been in England or on the Continent.

In dealing with high speed service with the ordinary overhead trolley construction, some difficulty was at first encountered in the method of supporting the wire. The form of support ordinarily used, by partially surrounding the wire, destroys the smoothness of the surface against which the wheel makes contact. Even at limited speeds of 8 to 12 miles an hour the trolley wheel strikes a perceptible blow on passing such a support, but when the speed is increased to 20 and 30 miles an hour or more, as it often is on inter-urban service, this blow throws the wheel away from the wire, and causes serious arcing.

To overcome this difficulty a so-called "figure 8" section of wire has been used to some extent. This provides a continuous and regular under surface. The use of this wire has been limited, however, on account of its tendency to kink badly in handling. Another form of support provides a perfectly smooth run-way for the wheel, and permits the use of standard round-section wire. In putting up a line with this method, the wire is milled at the points of support, as the work proceeds, by a special portable tool.

Ground Returns.

On a single-trolley line the question of track bonding is one of vital importance. The resistance of the rail joints must, of course, be kept at a minimum to secure best efficiency; but this is by no means the most serious consideration in applying electric traction to English conditions.

Under the Board of Trade regulations limiting the drop in the ground return to a maximum of 7 volts, methods of bonding that are practicable in American practice, where such a limit is not fixed, are entirely inadequate here. On an extended system in England it is, as a rule, the conductivity of the earth circuit that governs the design of the plant. It determines the necessary number of points of distribution, and the choice between direct and alternating current machinery in the generating station.

Various bonding devices have been adopted from time to time, and which provide ample conductivity when first installed, but very few of them possess the virtue of maintaining their contact in service. The bonding problem is a mechanical one. A serious difficulty in the development of electric traction has been to find means of rigidly supporting the rail ends, and the weakness of all metal bonds making contact by means of studs through the web of the rail is their liability of being worked loose by the up and down motion of the rails at the joint. The best way of making

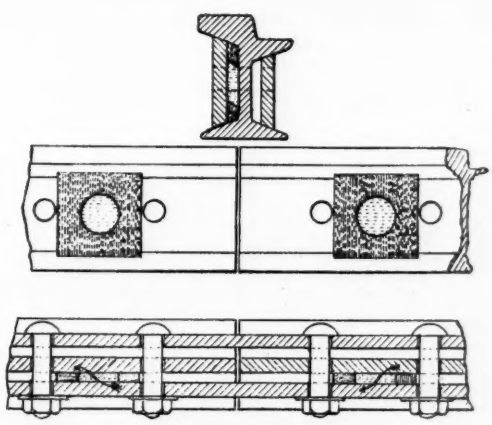


Fig. 4.

contact by means of a stud through the web is by spreading the metal in the stud out against the rail. The most effectual means of applying such a bond is the arrangement most commonly used at present in practice. The stud is hollowed out by drilling, and is driven into a hole in the rail which it fits tightly. A steel pin is then forced into the cavity in the stud, and, being slightly larger than the hole, it spreads the copper, bringing it into excellent contact with the rails. With this arrangement the hole in the rail may be made purposely irregular, and the copper in spreading will fill every crevice, increasing the maximum area of contact, and at the same time providing good mechanical means of preventing the stud from twisting or working loose. The projecting end of the stud may be turned back over the pin to prevent its backing out. Other methods have been adopted for making a contact of this kind, the stud being made solid, and spread by pressure

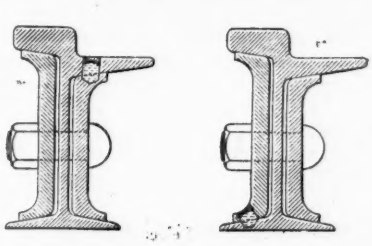


Fig. 5.

applied at the end; but it is much more difficult in this way to ensure perfect contact over the entire inner surface of the rail hole. With weak rail joints no bond of the stud type can be relied on to maintain permanent contact in service, no matter how firmly it may be set to begin with. Various arrangements of spring washers and gravity nuts have been tried to provide adjustment and absorb vibration, but without success.

A so-called plastic bond has been recently introduced which has shown good results in test. It provides a means of utilising the conductivity of the fish plates, no other solid conductors being

introduced. Fig. 4 shows the method usually followed in applying this bond. A section of elastic cork, of convenient shape, with a hole in the centre, is placed vertically against the side of the rail; the hole is then filled with a plastic amalgam, and the fish-plates bolted in place. The cork washer yields to the pressure of the fish-plates, allowing the amalgam to spread somewhat on the surface of the rail web and the inner side of the fish-plate, thus establishing the electrical connection. It is claimed for this material that it maintains its plastic condition and provides a permanent amalgamation of the metal surfaces. If this is so, it is clear that any ordinary vibration and motion at the joint will not affect the contact. Fig. 5 shows another means of making contact. A hole is drilled down from the top of the rail into the fish-plate, or from the base of the fish-plate into the base of the rail, the cavity being in either case filled with plastic material and covered with a small soft iron plug.

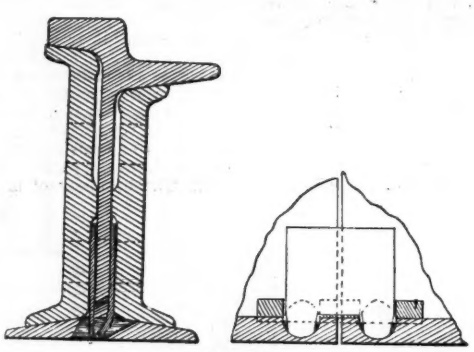


Fig. 6.

Fig. 6 shows still another method, which has somewhat the characteristics of a mercury cup connection. Holes are drilled into the abutting rails near the ends at the angle formed by the base of the web. These cavities are filled with the plastic amalgam, and receive the ends of a copper yoke, which spans the joint. No other means of contact is provided, and the yoke is held upright in position by the fish-plate. A joint of this kind will, it seems, allow a great deal of motion between the rails without disturbing the connection.

It must be remembered, however, that there are other considerations beside bonding which demand that movement at the rail joint should be prevented. With loose joints the whole car equipment is strained in service, and the cost of maintenance on the car body, the truck, and the motors is seriously increased.

In this connection the experiments with electrical and cast welded rail joints are worthy of attention. The idea of forming by these methods a continuous rail arose first from mechanical considerations and the great difficulty of maintaining rigid joints. During the past two or three years a great deal of experience has been gained with solid joints under various climatic conditions, and the results indicate that this practice will have an important bearing on permanent way construction, especially for electric traction when the rails form the return circuit.

(*To be continued.*)

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

8,602. "Improvements in electric lamp-holders and connections." Veritys, Limited, and M. B. Cotterell. Dated April 5th.

8,619. "Improved means of supplying current to electrically propelled railway or tramway vehicles." J. Enright. Dated April 5th.

8,639. "An improved method of electrically hardening or converting into steel the surfaces of iron plates and other objects made from iron. E. T. Zohrab. Dated April 5th.

8,663. "Improvements in dynamo-electric machines or electric motors." A. Holmes. (E. H. Johnson and R. Lundell, United States.) Dated April 5th.

8,665. "Improvements in or relating to trolley wheels." W. P. Thompson. (G. W. Duryea and T. W. Thompson.) Dated April 5th.

8,674. "Improvements in electric switches." A. C. Beckies. Dated April 5th.

8,696. "Improvements in secondary batteries or storage cells." A. P. Laurie. Dated April 6th.

8,703. "Improvements in electrical motors." A. D. Ellis and H. W. Appleby. Dated April 6th.

8,725. "Art of the apparatus for generating and distributing music electrically." R. A. Sloan. (T. Cahill, United States.) Dated April 6th. (*Complete.*)

8,774. "Improvements relating to electric incandescent lamps. A. J. S. Friard. Dated April 6th.

8,801. "Improvements in or relating to electric traction. L. B. Atkinson. Dated April 6th.

8,881. "Improvements in electric signalling apparatus for use on railway trains and the like." A. J. Williamson. Dated April 7th.

8,885. "Improvements in hand fed focussing electric lamps." J. E. Barnard, and T. A. B. Carver. Dated April 7th. (*Complete.*)

8,906. "Improvements in electric couplings." W. J. Davy, and G. T. Davies. Dated April 7th.

8,936. "Improved casing or conduit for concealing or isolating electric wires." E. Haslam. Dated April 8th.

8,944. "Improvements in arc lamps." H. M. Darrah. Dated April 8th.

8952. "Improvements in the method of and means employed for connecting lamps to electric conductor wires." F. Palm. Dated April 8th.

8,961. "Improvements in electric arc lamp mechanism." G. Percival. Dated April 8th.

8,970. "Improvements in electrical indicating apparatus and in couplings in connection therewith as a system for electrical communication." R. S. Hampson. Dated April 8th.

8,972. "Improved electric motor." W. R. V. Marshall. Dated April 8th.

8,995. "An improved make and break for induction coils and the like." J. King and C. H. Watson. Dated April 8th.

9,008. "Improvements in or connected with dynamo-electric machines." V. A. Fynn. Dated April 8th.

9,091. "Improvements in and relating to the distribution of electricity." H. F. Parshall. Dated April 9th. (*Complete.*)

9,095. "The unilever double current telegraph key." T. W. Andrews. Dated April 9th.

9,118. "Improvements in secondary voltaic batteries." L. Epstein. Dated April 9th.

9,126. "Improvements in the manufacture of filaments for incandescence lamps." C. H. Stearn. Dated April 9th.

9,127. "Improvements in electric meters." Evershead and Vignoles, Ltd., and S. Evershead. Dated April 9th.

9,135. "Electrical apparatus for automatically actuating ventilators, flue dampers, throttle valves, also for controlling and regulating sources of power."

9,166. "A method of and apparatus for erecting overhead electric conductors for railways and tramways." J. Werther and A. Schaffer. Dated April 10th.

9,173. "An electro-therapeutical lamp electrode." R. J. Mayer. Dated April 10th. (*Complete.*)

9,181. "Improvements in electric traction." H. W. Handcock and A. H. Dykes. Dated April 10th.

9,194. "Improvements in heating by electricity." O. March. Dated April 10th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d.* (*in stamps*).]

1895.

19,833. "Improvements in the electric propulsion of vehicles." A. G. New and A. J. Mayne. Dated October 22nd, 1895. Relates to the electric propulsion of velocipedes and other road vehicles. The rotating part of the motor forms the driving wheel of the machine. In the drawings the stationary part of the motor is shown secured to the fixed axle. The rotating part of the motor is journaled on the axle and forms the driving wheel. 1 claim.

20,237. "An improvement in electric safety fuses." Edison and Swan United Electric Light Company, Limited, and C. F. Proctor. Dated October 26th, 1895. The fuse wire is fitted on a holder so that it may be readily removed. A bridge piece of insulating material carries U-shaped contact plates, to which the fuse wire is clamped by means of nuts. The base carries notched contacts into which the contact pieces are dropped. A number of these may be fitted on one board. For connecting branches to a main the main is connected to a notched bar. 2 claims.

21,567. "Improvements in or relating to submarine telegraph cables." F. C. Crawford. Dated November 14th, 1895. Cables for submarine or other purposes are formed of a central conductor surrounded with India-rubber and overlapping spirals of tape. The next layer consists of spirals of wire having coatings of overlapping spirals of tape covered with sticky India-rubber. The outer coating of India-rubber is vulcanised, and the two sides may be of different colour or have ridges or other marks to show if the cable is twisted. 6 claims.

ERRATUM.

Electrical Review, No. 1,011, page 512. Abstract of Published Specification, No. 18,656 of 1896, should be 19,456 of 1896.